TM 11-5820-473-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DS, GS, AND DEPOT MAINTENANCE MANUAL

RADIO SETS AN/TRC-77 AND AN/TRC-77A

CR-18

$F_{trans} = f_{crystal}$

$F_{rec} = f_{crystal} - 455\ kHz$

HEADQUARTERS, DEPARTMENT OF THE ARMY

JUNE 1966

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 400-volt final amplifier plate circuit, the 175-volt keying bias and sidetone oscillator circuits, the 120-volt oscillator plate circuit, or the 115-volt ac line connection to the ac battery charger. Serious injury or death may result from contact with these points.

DON'T TAKE CHANCES!

CAUTION

Do not make resistance measurements on the transistorized circuits of Radio Sets AN/TRC–77 and AN/TRC–77A. (See paragraph 2–4 before making resistance measurements.)

TECHNICAL MANUAL
No. 11–5820–473–35

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *14 July 1966*

DS, GS, AND DEPOT MAINTENANCE MANUAL

RADIO SETS AN/TRC–77 AND AN/TRC–77A

			Paragraph	Page
CHAPTER	1.	FUNCTIONING OF RADIO SET AN/TRC–77(*)		
Section	I.	System functioning	1–1—1–3	1–1—1–2
	II.	System functioning of Radio Set AN/TRC–77(*)	1–4—1–5	1–2—1–4
CHAPTER	2.	TROUBLESHOOTING		
Section	I.	General troubleshooting techniques	2–1—2–3	2–1—2–3
	II.	Troubleshooting Radio Sets AN/TRC–77 and AN/TRC–77A	2–4—2–8	2–4—2–10
CHAPTER	3.	REPAIRS AND TUNING		
Section	I.	Repairs	3–1—3–4	3–1—3–4
	II.	Tuning	3–5—3–7	3–9
CHAPTER	4.	GENERAL SUPPORT MAINTENANCE		
Section	I.	Troubleshooting	4–1—4–5	4–1—4–4
	II.	General support repair procedures	4–6—4–9	4–7—4–9
	III.	General support alignment procedures	4–10—4–23	4–11—4–15
CHAPTER	5.	GENERAL SUPPORT TESTING PROCEDURES	5–1—5–17	5–1—5–23
CHAPTER	6.	DEPOT OVERHAUL STANDARDS, RADIO SET AN/TRC–77(*)	6–1—6–7	6–1—6–3
CHAPTER	7.	AUXILIARY EQUIPMENT	7–1—7–11	7–1—7–3
APPENDIX	I.	REFERENCES		A1–1
INDEX				I–1

*This manual, together with TM 11–5820–473–12, 7 October 1965, supersedes TM 11–5820–473–15, 30 August 962, including C 1, 23 August 1963.

CHAPTER 1

FUNCTIONING OF RADIO SET AN/TRC-77(*)

Section I. SYSTEM FUNCTIONING

1-1. Scope

a. This manual contains instructions for direct support, general support, and depot maintenance for Radio Sets AN/TRC-77 and AN/TRC-77A. It includes instructions appropriate to direct support, general support, and depot maintenance for troubleshooting, testing, tuning, aligning, and repairing the equipment, and replacing maintenance parts. It also lists tools, materials, and test equipment for direct support, general support, and depot maintenance. Detailed functions of the equipment are covered later in this chapter.

b. Official nomenclature followed by (*) is used to indicate all models of the equipment covered in this manual. Thus, Radio Set AN/TRC-77(*) represents Radio Sets AN/TRC-77 and AN/TRC-77A.

c. The direct reporting of errors, omissions, and recommendations for improving this manual by the individual user is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Publications) will be used for reporting these improvements. This form will be completed by pencil, pen, or typewriter, and forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-MR-NMP-CW, Fort Monmouth, N.J. 07703

Note. For other applicable forms and records, see TM 11-5820-473-12.

1-2. Internal Differences in Models

Internal differences are listed in the chart below. For external differences and other internal differences, see TM 11-5820-473-12.

Item	Radio Set AN/TRC-77	Radio Set AN/TRC-77A
C3, 5, 7, 9, 11, 13, 15, 17, 19, 23, 25, 206, through 211, 217, 218, 220, 221, 223 through 226, 228, 229, 231, 232.	1-90 pf	1-180 pf
C61	5 μf, 25 v	0.15 μf, 150 v
C62	1,000 pf	150 pf
C68	3-20 pf	2.8-16 pf
C214	3,300 pf	0.1 μf
C215	3,300 pf	0.047 μf
CR1, 55	Type 1N457	JAN1N457
CR51 through 54, 56, 57	Type 1N198	USN1N933
CR202	Type 1N459	JAN1N459
CR203	Type 1N748A	USN1N748A
CR204	Type 1N3015B	USA1N3015B
CR205	Type 4E20	Type 1N3489
CR301	Type 1.5M13Z5	USN1N3023B
CR302 through 321	Type 1N647	JAN1N647
CR322	Type 1N658	USA1N658
CR323	Serial numbers 60 and higher Type 1N457.	Type 1N1614
J51	Telephone jack type	Type U183/U (5 pin)

Item	Radio Set AN/TRC-77	Radio Set AN/TRC-77A
J301, 302	7-pin connector	2-pin connector
L211	220 uh	Not used
P301, 304	7-pin connector	2-pin connector
Q1 through 4, 51, 52, 56	Type 2N384	USA2N1225
Q53 through 55	Type 2N526	USN2N526
Q57	Type 2N338	USN2N338
Q201, 202	Type 2N1655	USA2N1234
Q301	Type 2N1039	USN2N1039
Q302	Type 2N1544	USA2N297A
Q303, 304	Type 2N174	JAN2N174
R13	Serial numbers 1 through 59-100 ohms. Serial numbers 60 and higher. 27 ohms	27 ohms
V201	Type 3B4A	USA3B4WA
V202	Type 2E24	JAN2E24
Capacitors C4, C8, C10, C12, C14, C16, C18, C20, C22, C24, C26, C216, C219, C223, C227, C230, C233, and RF AMP/MIXER, and PA tuning links.	Are contained in this model.	Are not available with this model.

1-3. System Applications

Radio Set AN/TRC-77(*) can be used for single-channel radio communications either in point-to-point or radio-relay system. The transmitter is operated by the auxiliary hand key or by an automatic keyer (not furnished with the radio set). The receiver is operative only when OFF-RCVR-XMIT switch S301 is in the RCVR position. Any one of six crystal-controlled frequency channels may be selected for both transmission and reception, and the frequencies selected for transmission and reception need not be the same.

Section II. DETAILED FUNCTIONING OF RADIO SET AN/TRC-77(*)

1-4. Block Diagram Analysis

Radio Set AN/TRC-77(*) is capable of receiving amplitude-modulation (am.) and continuous-wave (cw) signals and transmitting cw signals within the frequency range of 3 to 8 megacycles (mc). The signal paths in the receiver and transmitter section of the radio set are discussed below.

a. Transmitter Section (fig. 1-1).

(1) *Power.* Power for the transmitter is supplied by 12-volt battery BT301 or by an external power source. During transmitter operation, the input power is applied through OFF-RCVR-XMIT switch S301 to a preregulator circuit composed of Q301 and Q302, which limits the input voltage to 12 volts direct current (dc). The 12-volt dc output of the preregulator is applied to a dc-to-dc converter composed of Q303 and Q304 and associated rectifier circuits which provide +400 volts, +120 volts, and -175 volts for operation of the transmitter.

(2) *Oscillator V201.* Oscillator V201 is crystal-controlled and operates at any one of six preselected frequencies within the 3- to 8-megacycle range. The output of oscillator V201 is coupled to power amplifier V202.

(3) *Power amplifier V202.* Power amplifier V202 is a plate-tuned amplifier. Mechanical connection between plate tuning selection circuits and oscillator crystal selection circuits keeps the power amplifier tuned to the same frequency as the oscillator. The power

amplifier output is coupled to the antenna through ANT. TUNE switch S202 and coil L213.

(4) *Keyer Q201 and Q202.* The keyer circuit provides the changing electrical impulse to the final amplifier during transmission. The keyer circuit is a solid state device capable of switching from one state to another at a repetition rate of 300 pulses per second (pps). Its input can be either a conventional code key or an alternating electrical voltage representing a code pattern.

(5) *Sidetone oscillator CR205.* The sidetone oscillator is a relaxation oscillator that is activated during key code transmission. Internal wiring allows the audible frequency output to be applied to the last audio stage so that the operator may hear his own code in the headphones.

b. Receiver Section (fig. 1–2).

(1) The 3- to 8-megacycle signal selected by the tuned antenna circuits of the receiver is amplified by radiofrequency (RF) amplifier Q1. The amplified signal is applied to mixer Q2, where

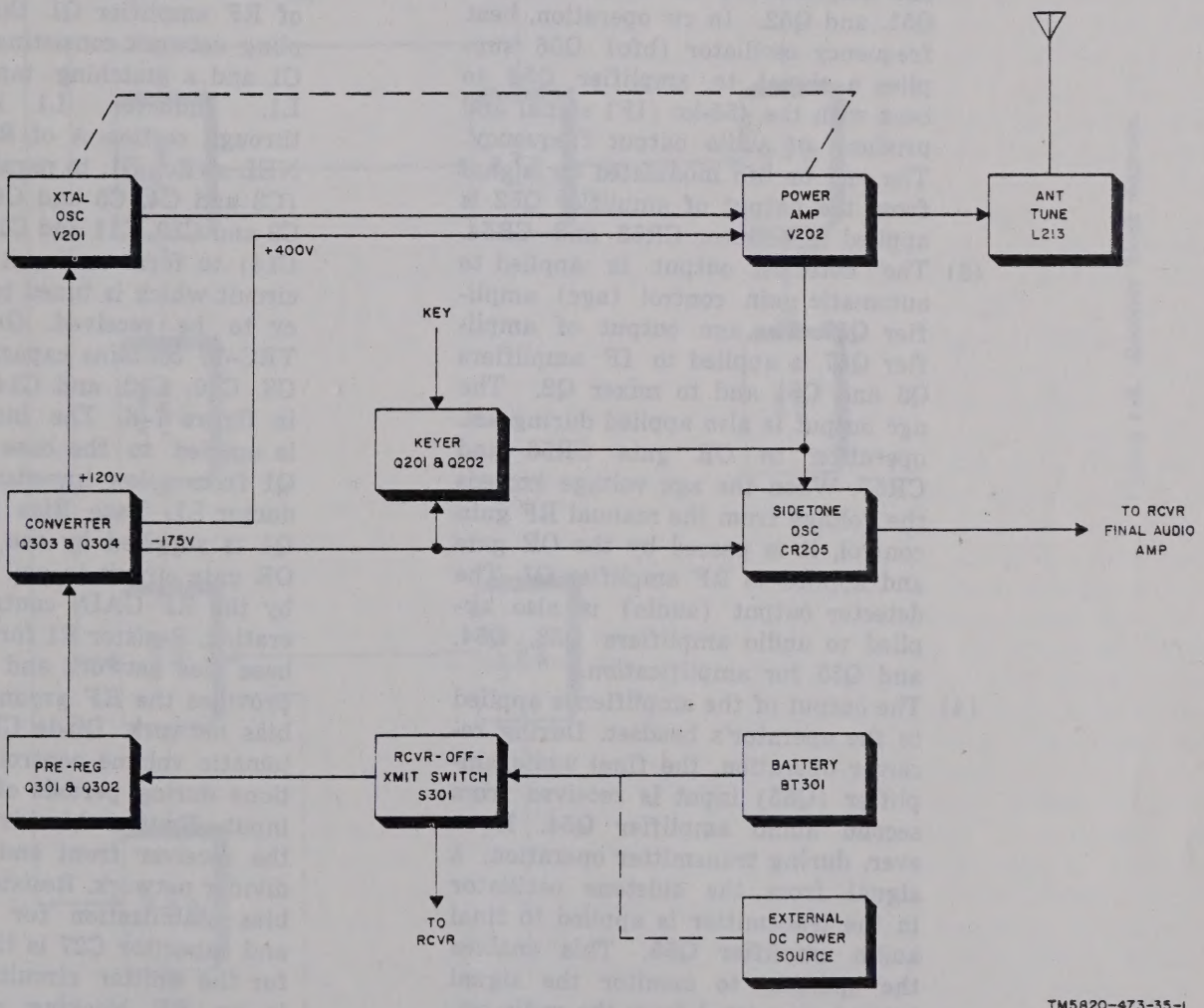


Figure 1–1. Transmitter block diagram.

it is mixed with the output frequency of crystal-controlled oscillator Q4. The output frequency of oscillator Q4 is always 455 kilocycles (kc) above the output signal of RF amplifier Q1 and the intermediate frequency (IF) output of mixer Q2 is always 455 kc. This is accomplished by mechanically connecting the antenna tuned circuits with the oscillator crystal selection circuits.

(2) The 455-kc mixer output is filtered by narrow bandpass ladder filter FL1 and amplified by IF amplifiers Q3, Q51, and Q52. In cw operation, beat frequency oscillator (bfo) Q56 supplies a signal to amplifier Q52 to beat with the 455-kc (IF) signal and produce an audio output frequency. The am. or bfo modulated cw signal from the output of amplifier Q52 is applied to detector CR53 and CR54.

(3) The detector output is applied to automatic gain control (agc) amplifier Q57. The agc output of amplifier Q57 is applied to IF amplifiers Q3 and Q51 and to mixer Q2. The agc output is also applied during am. operation to OR gate CR56 and CR57. When the agc voltage exceeds the voltage from the manual RF gain control, it is passed by the OR gate and applied to RF amplifier Q1. The detector output (audio) is also applied to audio amplifiers Q53, Q54, and Q55 for amplification.

(4) The output of the amplifier is applied to the operator's headset. During receiver operation, the final audio amplifier (Q55) input is received from second audio amplifier Q54. However, during transmitter operation, a signal from the sidetone oscillator in the transmitter is applied to final audio amplifier Q55. This enables the operator to monitor the signal being transmitted from the radio set.

1-5. Analysis of Operation

a. Receiver (fig. 7-6). The receiver is a highly selective superheterodyne type consisting of one RF stage, three IF stages, and three audiofrequency (af) stages of amplification. The selectivity of the receiver is primarily dependent upon the narrow bandpass characteristics of ladder filter FL1, emitter bypass filter FL2, and first IF transformer T1.

(1) *Antenna.* In receiver operation, the antenna functions as a lone wire nontunable antenna. Signals picked up by the antenna are fed through OFF-RCVR-XMIT switch S301 to the RF amplifier stage.

(2) *RF amplifier Q1.* Input signals from the antenna are applied to the base of RF amplifier Q1 through a coupling network consisting of capacitor C1 and a matching tap on inductor L1. Inductor L1 is connected, through section A of RCVR CHANNEL switch S1, to parallel capacitors (C3 and C4, C5 and C6, C7 and C8, C9 and C10, C11 and C12, or C13 and C14) to form an input parallel tank circuit which is tuned to the frequency to be received. Only the AN/TRC-77 contains capacitors C4, C6, C8, C10, C12, and C14 as indicated in figure 7-6. The incoming signal is applied to the base of transistor Q1 from a low impedance tap on inductor L1. Base Bias for transistor Q1 is supplied by the avc-RF gain OR gate circuit in am. operation and by the RF GAIN control in cw operation. Resistor R1 forms part of the base bias network and capacitor C2 provides the RF ground in the base bias network. Diode CR1 blocks automatic volume control (agc) variations during periods of weak signal input. Emitter bias is applied from the receiver front end B+ voltage divider network. Resistor R3 provides bias stabilization for transistor Q1 and capacitor C27 is the RF bypass for the emitter circuit. Inductor L3 is an RF blocking choke used to block RF signals from other receiver circuits. Resistor R2 provides emitter-to-base degenerative feedback for the RF amplifier stage. Degenerative

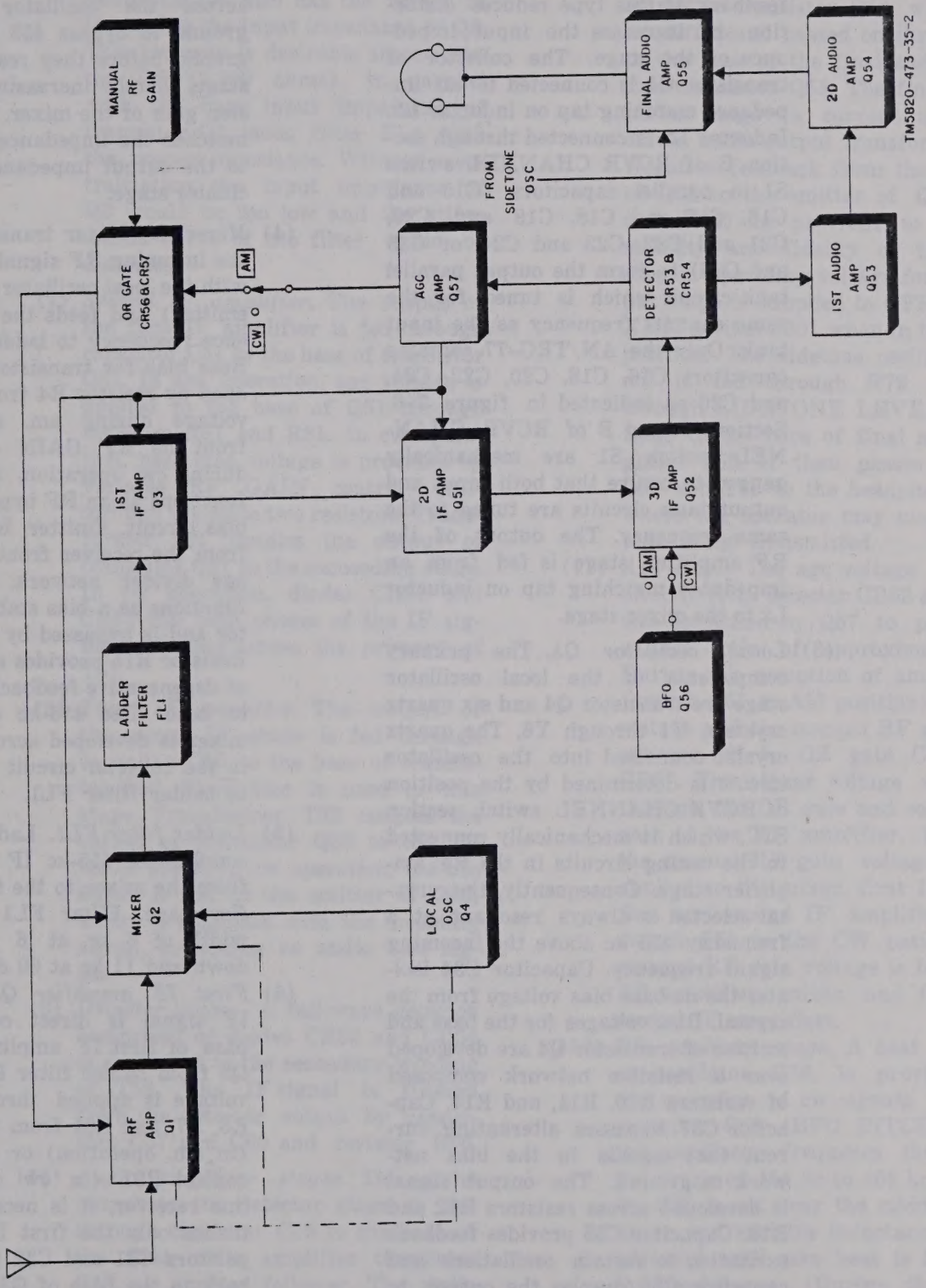


Figure 1-2. Receiver block diagram.

feedback of this type reduces distortion and increases the input impedance of the stage. The collector of transistor Q1 is connected to an impedance matching tap on inductor L2. Inductor L2 is connected through section B of RCVR CHANNEL switch S1 to parallel capacitors (C15 and C16, C17 and C18, C19 and C20, C21 and C22, C23 and C24, or C25 and C26) to form the output parallel tank circuit which is tuned for the same channel frequency as the input tank. Only the AN/TRC-77 contains capacitors C16, C18, C20, C22, C24, and C26 as indicated in figure 7-6. Sections A and B of RCVR CHANNEL switch S1 are mechanically ganged to insure that both input and output tank circuits are tuned to the same frequency. The output of the RF amplifier stage is fed from an impedance matching tap on inductor L2 to the mixer stage.

(3) *Local oscillator Q4.* The primary components of the local oscillator stage are transistor Q4 and six quartz crystals, Y1 through Y6. The quartz crystal connected into the oscillator circuit is determined by the position of RCVR CHANNEL switch section S1C, which is mechanically connected to the tuning circuits in the RF amplifier stage. Consequently, the crystal selected is always resonant at a frequency 455 kc above the incoming signal frequency. Capacitor C34 isolates the dc base bias voltage from the crystal. Bias voltages for the base and emitter of transistor Q4 are developed over a resistive network composed of resistors R10, R11, and R14. Capacitor C37 bypasses alternating current (ac) signals in the bias network to ground. The output signal is developed across resistors R12 and R13. Capacitor C35 provides feedback excitation to sustain oscillations and capacitor C36 couples the output to the mixer stage. Filter FL2 is series resonant at 455 kc and is inserted across the oscillator output and ground to bypass 455 kc signals to ground before they reach the mixer stage, thereby increasing the conversion gain of the mixer. Capacitor C38 matches the impedance of filter FL2 to the output impedance of the oscillator stage.

(4) *Mixer Q2.* Mixer transistor Q2 beats the incoming RF signal (on the base) with the local oscillator signal (on the emitter) and feeds the 455-kc difference frequency to ladder filter FL1. Base bias for transistor Q2 is developed by resistor R4 from the agc line voltage during am. operation and from the RF GAIN control (R91) during cw operation. Capacitor C29 functions as an RF bypass in the base bias circuit. Emitter bias is applied from the receiver front end B+ voltage divider network. Resistor R16 functions as a bias stabilization resistor and is bypassed by capacitor C39. Resistor R15 provides a small amount of degenerative feedback from emitter to base. The 455-kc output of the mixer is developed across resistor R5 in the collector circuit and is applied to ladder filter FL1.

(5) *Ladder filter FL1.* Ladder filter FL1 couples the 455-kc IF output signal from the mixer to the first IF amplifier stage. Filter FL1 has a bandwidth of 6 kc at 6 decibels (db) down and 11 kc at 60 db down.

(6) *First IF amplifier Q3.* The 455-kc IF signal is direct coupled to the base of first IF amplifier transistor Q3 from ladder filter FL1. Base bias voltage is applied through resistors R6, R7, and R81 from the agc circuit (in am. operation) or the RF GAIN control R91 (in cw operation). In this receiver, it is necessary to neutralize only the first IF stage. Capacitors C31 and C32 feed a voltage back to the base of Q3, which is out of phase with the voltage fed back from the collector to the base through

the base-to-collector capacitance. This neutralization also has the effect of increasing the input impedance of Q3. This increase is desirable since resistor R6 (2,200 ohms), in parallel with the base input impedance of transistor Q3, loads filter FL1 with the proper impedance. Without neutralization, the input impedance of Q3 would be too low and the attenuation curve of the filter would be distorted.

(7) *Second IF amplifier.* The output of the first IF amplifier is fed through capacitor C51 to the base of transistor Q51. In am. operation, agc voltage is applied to the base of Q51 through resistors R51 and R81. In cw operation, base bias voltage is provided by variable RF GAIN control R91, through the same two resistors. Transformer T51 couples the output of transistor Q51 to the succeeding stage. In cw operation, diodes CR51 and CR52 clip both phases of the IF signal appearing across the primary of T51.

(8) *Third IF amplifier.* The output of the second IF stage is fed through capacitor C55 to the base of transistor Q52. Fixed bias is used in this stage. Transformer T52 couples the output of transistor Q52 to the detector stage. In cw operation, the bfo signal is fed to the emitter of Q52, where it combines with the incoming signal, producing an audio *beat* signal.

(9) *Detector stage.* A full-wave detector comprised of diodes CR53 and CR54 is connected to the secondary winding of T52. The IF signal is filtered from the detector output by capacitors C57 and C60 and resistor R66.

(10) *Audio amplifier stages.* The audio output of the detector stage is fed through capacitor C59 to the base of the first audio amplifier transistor Q53, an emitter follower. The audio signal appearing across VOL control R69 is fed from the center tap through C61 to the base of the second audio amplifier transistor Q54, where it is amplified and passed on through C63 to the base of the final audio amplifier transistor Q55. The final af amplifier stage (a current amplifier) drives audio output transformer T53. Negative feedback from the collector of Q55 to the emitter of Q54 (C62 and R76) is provided to improve stability and fidelity of the audio stages. Operating voltage for the output stage is supplied to OFF–RCVR–XMIT switch S301 when in the RCVR position. The sidetone oscillator signal is fed through R79 and C63 through SIDETONE LEVEL control R223 to the base of final audio amplifier Q55. It then passes through Q55 and T53 to the headphone jacks where the operator may monitor the code being transmitted.

(11) *Agc stage.* The agc voltage is taken directly from detector CR53 and CR54 and amplified by Q57 to provide a voltage gain of approximately 15. During the reception of am. signals (switch S51 in AM position), the agc voltage and the manual RF gain voltage are fed to OR gate CR56 and CR57. The higher voltage will pass through the OR gate and control the gain of the RF amplifier. However, the manual RF gain voltage is not applied to the mixer, first IF amplifier, and second IF amplifier. With switch S51 in the CW position, the manual RF gain voltage is fed to the RF amplifier, mixer, and first and second IF amplifiers.

(12) *Bfo oscillator stage.* A beat frequency oscillator, Q56, is provided for the reception of cw signals. Variable capacitor C68 (BFO PITCH) tunes the oscillator frequency throughout the range of 454 kc to 458 kc. Initially, C68 is set near the middle of its range and variable inductance L51 is adjusted until zero beat is heard in the headphones. (During the initial adjustment of L51, an incoming signal to the receiver must be present

to generate the IF signal which beats with the bfo to produce an audio tone.) Operating voltage is supplied to the bfo stage by switch S51B when in CW position only. Feedback required to sustain oscillation is provided by C71 and R84. Bfo signal voltage is picked off at the junction of R84 and R85 and applied to the third IF amplifier stage through capacitor C76.

(13) *AM–CW selection switch.* The receiver is capable of either am. or cw reception. AM–CW selection switch S51 performs the following functions:

(*a*) Section C connects diode limiter CR51 and CR52 for cw operation and disconnects the limiter circuit for am. operation.

(*b*) Section B connects the 12-volt supply to the beat frequency oscillator for cw operation and disconnects it for am. operation.

(*c*) Section A connects the automatic gain and manual gain control for am. operation and the manual gain only for cw operation.

b. Transmitter (fig. 7–7). The transmitter consists of an oscillator, final amplifier, antenna matching circuits, keyer circuit, sidetone oscillator, and power supply. The transmitter is capable of being switched to any of six channels. Any one of the channels may be set to any frequency in the 3-to 8-megacycle band by plugging in the proper crystal and tuning the oscillator and final amplifier plate circuits of the corresponding switch position.

(1) *Oscillator.* The oscillator stage, V201, is a modified Pierce type having the capability of operating within a specified frequency tolerance of ± 0.008 percent throughout the required frequency range of 3 to 8 megacycles. Feedback required to effect oscillation of the stage is provided by capacitor C204. Six switch-selected sockets are provided to hold crystals having a frequency within the 3- to 8-mc range. A crystal within this range may be plugged into any socket. Switch S201 simultaneously selects the crystal socket and the corresponding plate tank circuit. The plate tank is then tuned to that particular crystal frequency by varying both the coil and the capacitor and observing a dip in voltmeter reading at test points TP201 and TP202.

(2) *Power amplifier V202.* The oscillator output is coupled to the power amplifier control grid by capacitor C212. Inductor L210 offers a high impedance to the operating frequency and thus blocks RF from the power supply. Opening the TUNE–OPERATE switch reduces output power of the transmitter while tuning the power amplifier plate and antenna circuits. This lowers power amplifier screen grid voltage and oscillator plate and screen grid voltages. Because switch S201D is ganged with the crystal selector switch; it selects a pretuned parallel capacitor pair in the power amplifier plate tank corresponding to the crystal channel selected. The primary of transformer T201 is the plate tank inductance. Tuning the tank circuit is accomplished by holding the key depressed and adjusting the tank capacitors for maximum glow of the OUTPUT INDICATOR.

(3) *Antenna circuit.* The output of power amplifier V202 is coupled to the antenna through transformer T201, variable inductor L213, and switch S301. The 12 tap positions on L213 provide a means of matching the inductive reactance of the inductor with the capacitive reactance of the antenna. ANT. TUNE switch, S202 is adjusted for maximum antenna current as indicated by ANT. TUNING INDICATOR DS201. The output indicator sensitivity switch S203 (INDICATOR RANGE) allows the indicator lamp brilliance to be adjusted to its most useful range.

(4) *Keyer circuit.* The transmitter final amplifier is keyed by changing the negative bias on the grid of V202

(–175 volts with key open, –15 volts with key closed). The fixed negative bias is kept on the tube when operating to avoid damage in case of loss of drive. Switching transistors Q201, and Q202 are used in the keying circuit to reduce the key current for automatic keying. When the key is open, the base voltage of Q201 is +12 volts. The emitter of Q202 is held at +3 volts; therefore the emitter-base junction is back biased and no current flows. Since no current flows in Q202, none can flow in Q201 and therefore there is no drop in R216 and R217, so that –175 volts appear at the grid of V202. When the key is closed the bases of the transistors are essentially at ground, the emitter of Q202 is still at +3 volts, so that now the emitter-base junction is forward biased and conducts. The emitter-collector voltage is very low, causing the emitter-base junction of Q201 to be forwarded biased. This allows the serious circuit CR203, Q202, R217, and R216 to conduct. The drop that appears across R216 is approximately 160 volts, leaving the grid of V202 at –15 volts.

(5) *Sidetone oscillator stage.* The four-layer diode, CR205, functions as a relaxation oscillator when properly biased by the keyer circuit as the key is operated. Feedback, which sustains oscillation, occurs internally between the diode layers. The frequency of the resultant audio tone is determined by the time constant of capacitor C236 and resistor R221. Capacitor C237 and potentiometer R223 couple the tone to the audio amplifier of the receiver to provide the capability of monitoring.

(6) *Preregulator.* Normally, the radio set operates from its own battery. However, when it is necessary to operate from an external source, such as one-half of a jeep battery, the preregulator is used to reduce the voltage into the converter to about 12 volts. (One half of a jeep battery with the generator running could develop as much as 17 volts.) The preregulator is composed of Q301 and Q302. The voltage reference is Zener diode CR-301. This diode, in series with R301, is connected across dc input. With normal input voltage (12.6 volts), Q301 and Q302 are conducting the converter current with 0.6- to 0.7-volt drop. As the input voltage increases, the base drive of Q301 and Q302 is decreased and the voltage drop across them is increased so that the voltage across the converter remains relatively constant. The external battery may be connected either by the auxiliary power cable, which is plugged in the place of the internal battery to J301, or +12 volts may be connected to terminal J303 with the negative battery terminal connected to the case.

(7) *Dc-to-dc converter.* The dc-to-dc converter consists of a square wave generator circuit on the primary side of transformer T301 and a bridge rectifier circuit on the secondary side of T301. The converter increases the 12–volt battery voltage to higher dc operating voltages as required by the transmitter. The square wave generator is a conventional switching circuit with the exception of diodes CR302 and CR303 and their counterparts CR304 and CR305 in the other half of the circuit. Diode CR302 provides a low impedance path for normal base drive current. However, when Q303 is not conducting, CR303 provides a path for base-to-emitter current to provide back bias of this junction. This insures that Q303 does not conduct during the period when it should be cut off. Capacitor C301 decreases both the turn-on and turn-off time of the switching transistors. The bridge rectifier circuits supply +400 volts to the power amplifier, +120 volts to the oscillator, and –175 volts for keying bias and sidetone

oscillator supply voltage. Filament voltage for the power amplifier tube (6.3 volts root mean square (rms)) and the oscillator tube (2.5 volts rms) is supplied directly from transformer T301.

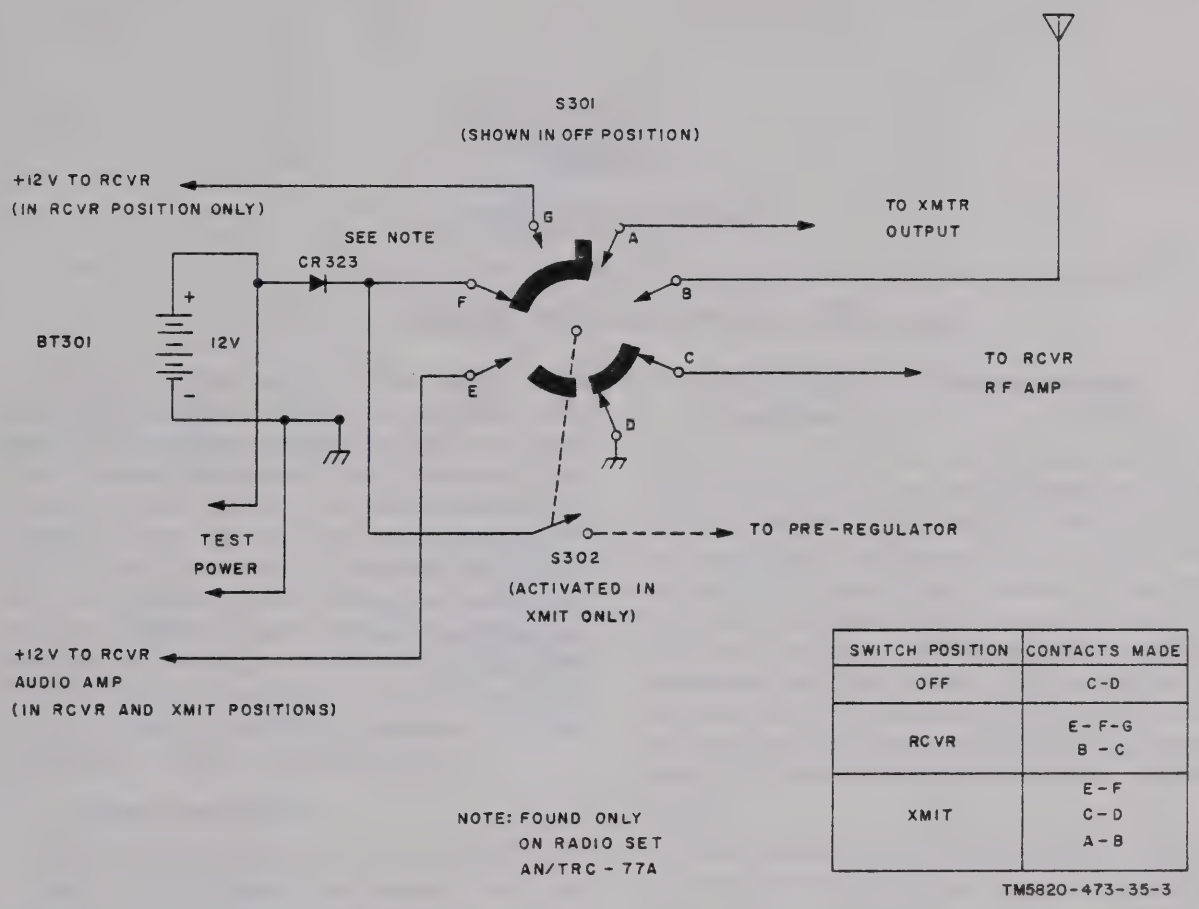
(8) *Battery.* The battery (Battery Assembly B-447/TRC-77(*)) is composed of 10 BB-418/U cells each supplying 1.2 volt. The electrolyte is a 30-percent solution of potassium hydroxide; the plates are of nickel and cadmium. The specific gravity of the electrolyte is 1.300 but does not vary with the state of charge of the cell. However, the level of the electrolyte goes down as the battery is discharged and rises when the battery is charged. This caused by a swelling of the plates during charge and the electrolyte is squeezed out of the spacing material. Therefore, distilled water should not be added to the battery except after it has been allowed to set several hours fully charged. The battery is rated at 14 ampere-hours and will operate the transmitter for about 5 hours. The receiver draws only about 15 milli amperes and will operate continuously for about 30 days on one full battery charge.

(9) *OFF-RCVR-XMIT switch* (fig. 1-3). OFF-RCVR-XMIT S301, in addition to its normal power switching function, performs the following functions in the XMIT position:

(*a*) Grounds the receiver antenna to prevent damage to first RF transistor Q1.

(*b*) Actuates switch S302 by means of a cam so that the transmitter current does not pass through the contacts of S301.

(*c*) Switches power to the receiver final audio amplifier so the sidetone oscillator signal is heard in the headphones.



SWITCH POSITION	CONTACTS MADE
OFF	C-D
RCVR	E-F-G B-C
XMIT	E-F C-D A-B

Figure 1-3. Power selection switch simplified schematic diagram.

CHAPTER 2

TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: **When servicing the radio set, be extremely careful because of the high voltages. Except when testing transmitter operation, always disconnect the telegraph key from the KEY jack. This will prevent accidental closing of the key when the OFF-RCVR-XMIT switch is positioned at XMIT and the resulting high voltage appearing at the ANT binding post. When handling the lead to the plate cap of power amplifier tube V202, always be sure that OFF-RCVR-XMIT switch is not in the XMIT position. In this position, 400 volts is on the plate lead.**

2-1. General Instructions

The DS, GS, and depot maintenance procedures in this manual supplement the procedures described in the organizational maintenance manual. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at the organizational category, is carried to a higher category in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting procedures are more advanced. The information, techniques, and procedures contained in this section apply to all categories of DS, GS, and depot maintenance and are intended for use consistent within the limitations of equipment and personnel at each maintenance category. Section II contains specific troubleshooting procedures which may be used at all DS, GS, and depot maintenance activities. Where a troubleshooting procedure is required which cannot be performed at all DS, GS, and depot maintenance activities, it has been omitted from section II and a reference has been made to the appropriate maintenance chapter.

2-2. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to a major component. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing, and shorted transformers, can often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and continuity.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work, and to aid in tracing trouble in a defective radio set. Radio Sets AN/TRC-77 and AN/TRC-77A consist of three main sections: the receiver, the transmitter, and the power supply. The first step is to locate the section or sections at fault by the methods given in *a* and *b* below. All the components mounted on the receiver front end assembly printed circuit board (fig. 4-4) and the receiver IF and AF assembly printed circuit board (fig. 4-5) are assigned general support maintenance. Whenever sectionalizational troubleshooting indicates that the trouble is associated with these receiver printed circuit boards, general support maintenance is required.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All seemingly overheated components, frayed wires, loose connections, broken knobs, or other visual signs should be observed and an attempt

made to sectionalize the fault to a particular unit.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. The equipment performance instruction (TM 11–5820–473–12) is a good operational test.

c. Localization. After the trouble has been sectionalized (*b* above), the methods listed in (1) and (2) below will aid in localizing the trouble to a stage or circuit in the suspected section.

(1) *Minor test points.* The minor test points (para 2–8) cover critical signal path junctions that aid in localizing a trouble within the transmitter and power supply sections. These tests also help determine whether general support troubleshooting of the receiver is required.

(2) *Troubleshooting chart.* The trouble symptoms listed in the troubleshooting chart (para 2–6(*a*)) provide additional information for localizing trouble and for isolating trouble to a faulty component.

d. Isolation. After the trouble has been localized (*c* above), the methods in (1) through (5) below will aid in isolating the trouble to a defective circuit element.

(1) *Voltage measurements.* This equipment is transistorized. When measuring voltages, use tape or sleeving (spaghetti) to insulate the entire prod, except for the extreme tip. A momentary short circuit can ruin the transistor. Use the same or equivalent electronic multimeter (vtvm) specified in the minor test point measurements (para 2–8).

(2) *Resistance measurements.* Except for resistance measurements taken before applying power as directed in paragraph 2–4, resistance measurements are restricted to the detection of open or shorted components, leaky capacitors, or continuity checks of components and wire paths. Because of the nature of the transistorized equipment, control settings and an abundance of miniature electrolytic capacitors, in-circuit values tend to mislead and slow down the troubleshooting procedure. Since the majority of stages consist of transistors (current-biasing devices), the transistor dc voltage bias measurements taken at the minor test points (para 2–8) provide adequate determining factors for isolating components.

Caution: **Before using any ohmmeter to the test transistors or transistor circuits, check the open circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if the open circuit voltage exceeds 1.5 volt. Also, since the RX1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 milliamperes (ma) or more) may damage the transistor under test. As a general rule, it is not recommended that the RX1 range of any ohmmeter be used when testing low power transistors.**

(3) *Major test points.* The major assemblies of this radio set are equipped with test jacks to facilitate connection of test equipment. The test jacks should be used whenever possible to avoid needless puncturing of the protective epoxy coating on the printed circuit boards. Each test jack, function, and location are listed in the following chart:

Test jack	Normal function	Assembly location
TP1	Injection of IF signal and troubleshooting test point for isolating mixer and IF amplifier crossover signals.	Receiver—front end assembly (fig. 4–1)
TP51	Injection of IF signals and troubleshooting test point for isolating detector and third IF amplifier signals.	Receiver IF and af assembly (fig. 4–2)
TP52	Injection of audio signals and trouble-shooting test point for isolating detector and audio amplifier signals.	Receiver IF and af assembly (fig. 4–2)
TP201 TP202	Used in combination to determine operation of oscillator V201.	Transmitter-oscillator and keyer assembly (fig. 2–3)
TP301	Measurement of 400-volt circuit in power supply.	Power supply—printed circuit board (fig. 2–4)

(4) *Intermittent troubles.* In all the tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Make a visual inspection of the wiring and connections to the units of the set. Minute cracks in printed circuit boards can cause intermittent operation. A magnifying glass is often helpful in locating defects in printed boards. Continuity measurements of printed conductors may be made by use of the same technique ordinarily used on hidden conventional wiring. Observe ohmmeter precautions discussed in the caution of (2) above.

(5) *Resistor and capacitor color code diagrams.* Resistor and capacitor color code diagrams (figs. 7–4 and 7–5) are provided to aid maintenance personnel in determining the value, voltage rating, and tolerance of capacitors and resistors.

2–3. Test Equipment Required

The following chart lists test equipment and the associated technical manuals required for troubleshooting Radio Sets AN/TRC–77(*).

Caution: **This equipment contains transistor circuits in both the transmitter and receiver chassis. If any equipment item does not have an isolation transformer in its power supply circuit, connect one in the power input circuit. A suitable transformer is identified by FSN 5950–356–1779.**

a. Never connect test equipment (other than multimeters and vtvm's) outputs directly to a transistor circuit; use a coupling capacitor.

b. Make test equipment connections with care so that shorts will not be caused by exposed test equipment connectors. Tape or sleeve (spaghetti) test prods or clips as necessary to leave as little exposed as needed to make contact to the circuit under test.

c. The equipment battery (or its equivalent) normally used is recommended as the source of power when servicing transistorized equipment. Observe battery polarity. Polarity reversal may damage the transistors or electrolytic capacitors in the circuit. If a battery eliminator is used in place of the battery normally used with the equipment, it must have good voltage regulation and low ac ripple. Good regulation is important, because the output voltage of the battery eliminator (which has poor regulation) may exceed the maximum voltage rating of the transistors in the equipment being tested. A battery eliminator that has poor ac filtering will create a false indication of poor filtering in the equipment being tested.

d. The transistorized equipment must be turned off before switching the battery eliminator on or off. The transient voltages, created by switching the battery eliminator on and off, may exceed the *punch-through* rating of the transistors. Also, make sure that a normal load (such as headphones for a receiver) is connected to this transistorized equipment before applying power.

e. The following chart lists test equipment required for troubleshooting Radio Set AN/TRC–77(*). Also listed are associated technical manuals and common names.

Test equipment	Technical manual	Common name
Multimeter ME-26B/U	TM 11-6625-200-12	VTVM
Multimeter TS-352/U	TM 11-5527	Current meter
Oscilloscope AN/USM-140A	TM 11-6625-535-15	Oscilloscope
Test Set, Electron Tube TV-7U	TM 11-6625-274-12	Tube tester
Output Meter TS-585D/U	TM 11-5017	Audio power meter
Voltmeter, Electronic ME-30B/U	TM 11-6625-320-12	VTVM
Test Set, Transistor TS-1836/U	TM 11-6625-539-15	Transistor testor
Signal Generator SG-299/U	TM 11-5134-15	Square wave generator
RF Signal Generator AN/URM-25F	TM 11-5551E	RF signal generator
Wattmeter AN/URM-120	TM 11-6625-446-15	Wattmeter
Voltmeter, Electronic AN/URM-145	TM 11-6625-524-14	RF voltmeter
Frequency Meter AN/USM-26	TM 11-5057	Counter

Section II. TROUBLESHOOTING RADIO SETS AN/TRC-77 AND AN/TRC-77A

Caution: **Do not attempt removal or replacement of parts before reading the instructions in paragraph 2-4.**

2-4. Checking for Short Circuit Before Applying Power

a. When to Check. When any of the following conditions apply, check for short circuits and clear the troubles before applying power:

(1) When the nature of the abnormal symptoms is not known.
(2) When abnormal symptoms reported from operational tests indicate possible power supply troubles.
(3) When sectionalizing procedures have indicated possible power supply trouble.

b. Conditions for Tests. Prepare for the short circuit tests as follows:

(1) Remove the radio set from its outer case.
(2) Remove any external power.
(3) Follow the required control settings for the radio set and ohmmeter used during each measurement as stated in the short circuit tests (*d* below).

c. Measurements.

Caution: **This equipment is transistorized. Review paragraph 2-3*a* before performing resistance measurements.**

Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

d. Short Circuit Tests.

Note. All measurements are made between the *point of measurement* as indicated in the chart and ground.

Point of measurement	Normal indication	Isolating procedure
Soldered terminal mounted on jack J302 bracket with switch S301 in RCVR position.	1,000 ohms	If indication is low, check capacitors C42, C43, and C75 and diodes CR56 and CR57.
Same as above except: switch S301 in XMIT position.	13 ohms	If indication is low, check transistors Q303 and Q304.
Plate cap of tube V202	470K ohms	If indication is low, check capacitors C305 and C306, inductor L301, resistor R308, and diodes CR306 through CR313.
Pin 7 of tube V201	140K ohms	If indication is low, check capacitors C307 and C308, resistors R306 and R309, and diodes CR314 through CR317.
-175 eyelet on keyer and oscillator printed circuit board.	290K ohms	If indication is low, check capacitors C309 and C310, resistor R307, and diodes CR318 through CR321.

2–5. Test Setup

(figs 2–1 and 2–2)

Bench tests of Radio Sets AN/TRC–77(*) require connection to a power source and to various test equipments. The power source must be connected to the AN/TRC–77(*) for all dynamic servicing procedures; the test equipment connections vary from test to test. Remove the AN/TRC–77(*) from its outer case and make a test setup as described below.

Caution: **To avoid transistor damage, refer to the caution notice given in paragraph 2–4, before making the connections described in *a* and *b* below.**

a. Power Supply Connections.

(1) Battery assembly BB–447 and battery assembly BB–447A are used with Radio Sets AN/TRC–77 and AN/TRC–77A, respectively, in normal operating installations.

(2) For test purposes, connect a power supply capable of delivering a variable output from 10 to 17 volts at 6 amperes across TEST POWER jack J302 (fig. 2–1) through alligator clips provided with the power supply. The radio set chassis is always. connected to the NEGATIVE side of the power supply.

b. Test Equipment. Connect the test equipment as specified for the particular tests. Figure 2–1 shows the test connections for localizing troubles to the transmitter section. Figure 2–2 shows a typical signal injection test setup.

2–6. Localizing Troubles

a. General. Procedures are outlined in the following chart for sectionalizing troubles to the receiver, transmitter, and power supply sections of the radio set. In addition, these procedures aid in localizing and sometimes isolating to various stages, circuits, and components in the receiver, transmitter, and power supply sections. Parts location is indicated in figures 3–1 through 3–8. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in localization of trouble to a particular stage, use the techniques outlined in paragraph 2–7 to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting chart is designed to supplement the operational checks detailed in TM 11–5820–473–12. If previous operational checks have resulted in reference to a particular item, go directly to the referenced item. If no operational symptoms are known, refer to TM 11–5820–473–12 and conduct procedures until trouble and symptoms are located.

c. Conditions for Tests. All checks outlined in the troubleshooting chart are to be conducted with the radio set connected to a power source as described in paragraph 2–5*a* and appropriate loads as described in the operation and organizational manual (TM 11–5820–473–12) and as shown in the test setup illustration (fig. 2–1).

Caution: **If operational symptoms are not known, or they indicate the possibility of short circuits within the receiver, make the short circuit checks described in paragraph 2–4 before applying power to the unit.**

d. Troubleshooting Chart.

Note. Unless trouble has already been localized, perform the operational checks given in the operator's manual (TM 11–5820–473–12) before using this chart.

(1) Transmitter.

Item	Indication	Probable trouble	Procedure
1	Transmitter inoperative ------	Poor power supply connections --	Check cable and connections to power source.
		Defective power selection switch S301.	Check switch S301 for faulty mechanical or dirty contacts. Clean contacts, if dirty. Replace switch, if defective.
		Defective safety bypass switch S302.	Check switch S302 for faulty mechanical operation. Replace switch, if defective.

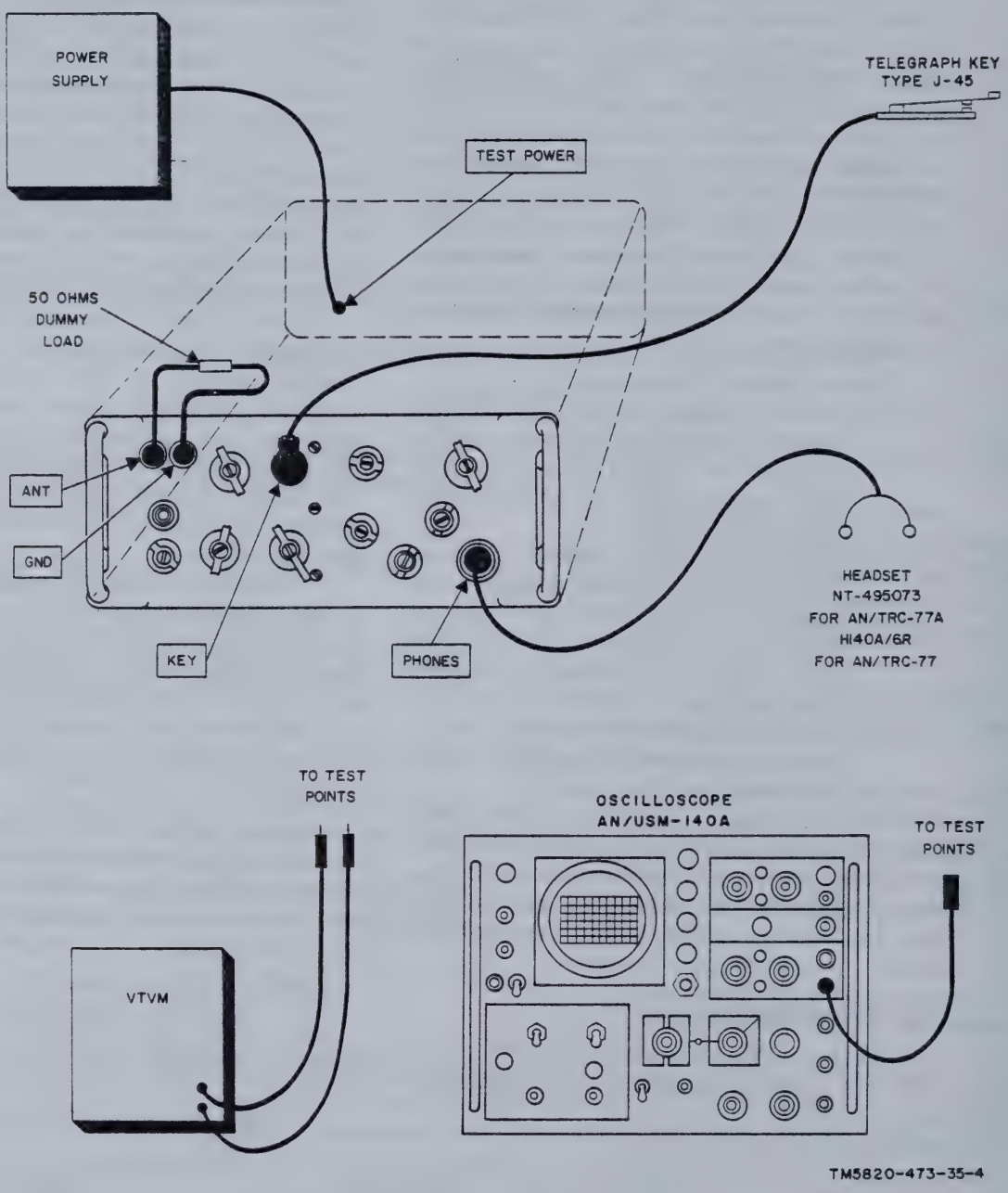


Figure 2-1. Troubleshooting test setup.

(1) *Transmitter* (cont.)

Item	Indication	Probable trouble	Procedure
		Defective dc-to-dc convertor ----	Check converter output voltages. If absent or incorrect, check circuit components for defects. Replace defective components.

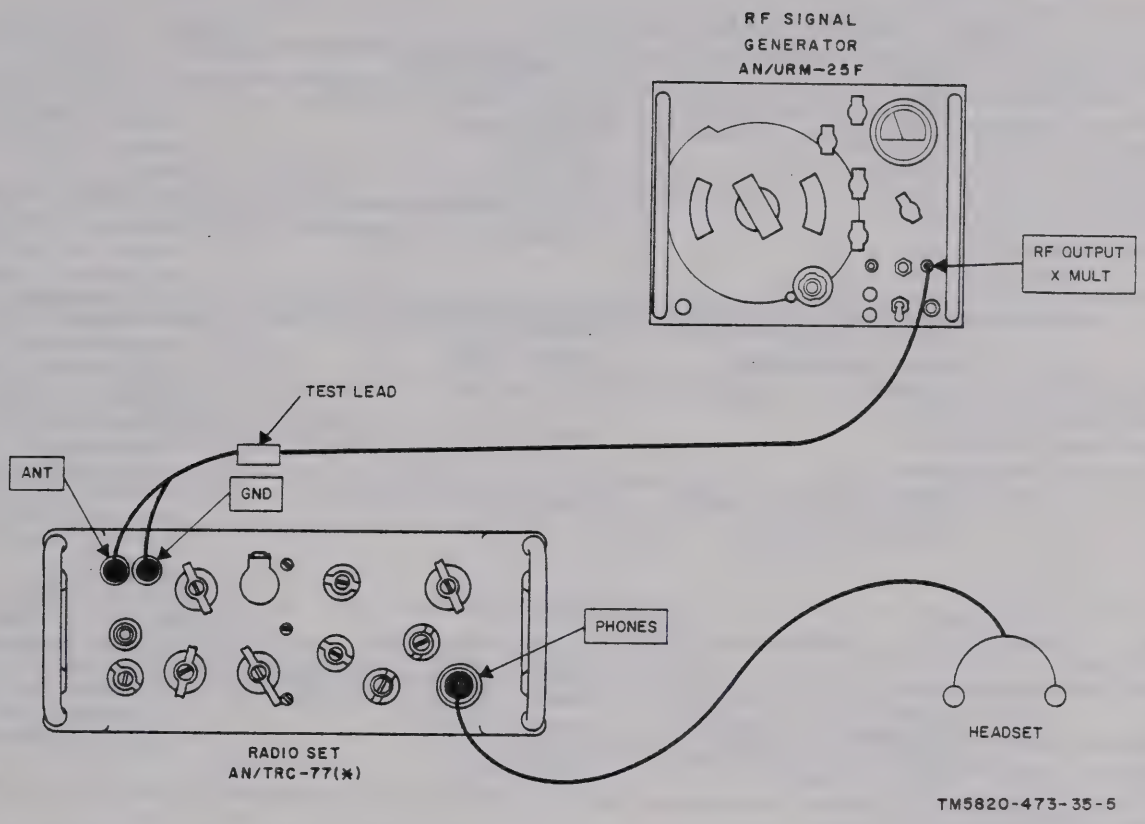


Figure 2–2. Signal injection test setup.

(1) *Transmitter* (cont.)

Item	Indication	Probable trouble	Procedure
2	No output	Defective POWER AMPLIFIER	Check tube V202 by substitution. Replace, if defective. Perform voltage checks (para 2–8*c(2)*; if abnormal, perform resistance checks (power off) (fig. 2–6).
		Defective OSCILLATOR	Check tube V201 by substitution Replace, if defective. Perform voltage checks (para 2–8c (1)) if abnormal, perform resistance checks (power off) (fig. 2–6).
		Defective dc-to-dc convertor	Check converter output voltages. If absent or incorrect, check circuit components for defects. Replace defective components.
3	Weak output	Improper tuning	Check transmitter tuning (para 3–7). Retune, if necessary.
		Low converter output voltage	Check converter output voltages. If low, check for defective circuit components. Replace defective components.

(1) *Transmitter* (cont.)

Item	Indication	Probable trouble	Procedure
4	Poor channel selection (will not operate on all channels selected).	Defective XMTR CHANNEL switch S201.	Check switch for faulty mechanical operation and continuity. If defective, replace switch.
		Defective channel crystal or channel tuning components.	Check crystal by substitution. Replace, if defective. Check channel tuning components and replace, if defective.
5	OUTPUT INDICATOR bulb erratic during normal operation.	Defective INDICATOR RANGE switch S203.	Check switch for faulty mechanical operation and dirty contacts. Clean contacts, if dirty. Replace switch, if defective.
		Defective resistor network ------	Check resistors R210, R220, and R203. Replace, if defective.
6	No sidetone heard in headset when key is closed.	Defective sidetone oscillator ----	Check diode CR205 and associated components C236, R222, R221, and R223. Replace defective components.
		Defective keyer ----------	Perform voltage checks (para 2–8*c*(1)), if abnormal, replace defective components.
7	Transmitter power output is not reduced when TUNE/OPERATE switch is operated to TUNE.	Defective TUNE/OPERATE switch S204.	Check switch for faulty mechanical operation and for continuity. Replace, if defective.

(2) *Receiver.*

Item	Indication	Probable trouble	Procedure
1	Weak audio output with VOL control R69 at maximum.	Improper tuning ----------	Check receiver tuning (para 3–7). Retune, if necessary.
		Weak battery ----------	Check battery voltage.
2	No output ----------	Defective headset ----------	Check headset by substitution.
		Defective PHONES jack J51 ----	Check jack J51 for continuity.
		Defective components on printed circuit boards.	Refer to higher maintenance category.
3	No operation in CW mode but operates in AM mode or reverse.	Defective AM/CW switch S51 ---	Check switch S51 for continuity, mechanical operation, and burned or dirty contacts. Replace switch, if defective. Clean contacts, if dirty.
4	Intermittent output in CW or AM mode.	Poor antenna connections --------	Check antenna connections. Repair, if faulty.
		Defective headset ----------	Check headset by substitution, and replace if defective.
		Defective PHONES jack J51 ----	Check jack J51 for continuity. Repair jack side of wires, if faulty.
5	Poor channel selection, (does not operate on all channels).	Defective RCVR CHANNEL switch S1.	Check switch S1 for faulty mechanical operation and dirty contacts. Replace switch, if defective. Clean contacts, if dirty.

(2) *Receiver* (cont.)

Item	Indication	Probable trouble	Procedure
		Defective channel crystal	Check crystal by substitution. Replace, if defective.
		Defective channel tuning components.	Check channel tuning components and replace, if defective.
6	Audio distortion while adjusting volume control.	Defective VOL control R69	Check for loose connections and faulty mechanical operation. Repair connections. Replace control, if defective.
7	Noise in headset when changing channels.	Dirty contacts on switch S1	Clean switch contacts.
8	Intermittent audio heard in headset while adjusting BFO PITCH in CW mode.	Defective BFD PITCH control	Check pitch control capacitor C68 for dirt between plates or for rubbing plates. Clean if dirty. Replace, if plates are rubbing.

(3) *Power Supply.*

Item	Indication	Probable trouble	Procedure
1	No converter output voltages (+120, +400, -175).	Defective battery BT301	Check battery voltage. If low, or absent, recharge battery or replace cells.
		Defective preregulator Q301 and Q302.	Perform voltage measurements on pre-regulator Q301 and Q302 para 2-8*c*(3)). If incorrect, check for defective circuit components and replace, if components are defective.
		Defective multivibrator Q303 and Q304.	Perform voltage measurements on multivibrator Q303 and Q304 (para 2-8*c*(5)). If incorrect, check for defective circuit components and replace if components are defective.
		Defective transformer T301	Check primary and secondary windings of transformer T301. If defective, replace the transformer.
2	No +400-volt output (other voltages correct).	Defective components in +400-volt circuit.	Check diodes CR306 through CR313, capacitors C305 and C306, inductor L301, and resistor R308. Replace defective components.
3	No +120-volt output (other voltages correct).	Defective components in +120-volt circuit.	Check diodes CR134 through CR317, capacitors C307 and C308, and resistor R309. Replace defective components.
4	No -175-volt output (other voltages correct).	Defective components in -175-volt circuit.	Check diodes CR318 through CR321, capacitors C309 and C310, and resistor R307. Replace defective components.

2–7. Isolating Trouble Within Stage

a. General. When trouble has been localized to a stage, either through operational checks or the troubleshooting chart, isolate the defective part by voltage measurements or continuity measurements.

Caution: **Before attempting to perform voltage and resistance measurements, review paragraph 2–3. Carefully follow instructions and observe notes on voltage and resistance charts; carelessness may cause more troubles in the equipment and make the troubleshooting job more difficult. Do not remove or insert a transistor with voltage applied to the circuit.**

b. Transistor Testing. The transistors used in this radio set are wired in the circuit. Every effort should be made to troubleshoot the equipment without physically unsoldering and removing the transistors. Use the transistor tester for making in-circuit checks.

c. Weak Signal. If signals are weak and all checks fail to indicate a defective part, check the tuning of the receiver (para 3–7).

d. Schematic Diagram. Use the schematic diagrams (figs. 7–6 and 7–7) to circuit trace and isolate the faulty part.

2–8. Minor Test Points

a. General. The minor test points for direct support troubleshooting are incorporated in the five voltage charts (*c*(1) through (5) below)) and serve to aid in isolating troubles to components within the transmitter and power supply sections. The oscillator, keyer, and power amplifier voltage charts (*c*(1) and (2) below)) encompass the minor test points for the transmitter section; the preregulator and dc converter voltage charts (*c*(3) and (5) below)) cover the minor test points for the power supply section. The voltage charts can be used for sectionalization and localization in addition to isolation to specific circuits.

b. Conditions for Measurements.

(1) Remove the radio set from its outer CASE.

(2) Connect the transmitter to its normal antenna load or an equivalent impedance.

(3) Observe the caution in paragraph 2–4 and apply an external power source as indicated in paragraph 2–5.

Note. The preregulator voltage chart given in paragraph *c*(4) below requires an input voltage of +17 volts dc.

(4) Measure the voltage from the point of test indicated to ground; use the test equipment called out in the respective chart.

(5) Refer to the figure or figures called out for each chart to identify the physical location of the test points when other than tube sockets.

c. Minor Test Point Charts.

(1) *Oscillator and keyer assembly* (fig. 2–3).

Point of test	Test equipment	Voltage to ground	
		Key up	Key down
V201 pin 1	VTVM	+95 vdc	----
V201 pin 3	VTVM	–20 vdc	----
V201 pin 4	Oscilloscope	3 volts pk to pk	----
V201 pin 5	Oscilloscope	3 volts pk to pk	----
V201 pin 7	VTVM	+118 vdc	----
Point A	VTVM	11.25 vac	----
Point B	VTVM	+95 vdc	----
Point C	VTVM	–170 vdc	–36 vdc
Point D	VTVM	+118 vdc	----
Point E	VTVM	+118 vdc	----
Point F	VTVM	+118 vdc	----
Q201 emitter	VTVM	–89 vdc	+2.18 vdc
Q201 Base	VTVM	–88 vdc	+1.59 vdc
Q201 collector	VTVM	–170 vdc	+2.18 vdc
Q202 emitter	VTVM	+3.8 vdc	+3.6 vdc
Q202 base	VTVM	+12 vdc	+1.7 vdc
Q202 collector	VTVM	–85 vdc	+2.3 vdc

(2) *Power amplifier assembly* (fig 2-4).

Point of test	Test equipment	Voltage to ground	
		Key up	Key down
V202 pin 2	Oscilloscope	6.6 volts pk to pk	6.6 volts pk to pk
V202 pin 3	VTVM	+196 vdc	+192 vdc
V202 pin 5	VTVM	-170 vdc	-72 vdc
V202 pin 7	Oscilloscope	6.6 volts pk to pk	6.6 volts pk to pk
V202 cap	VTVM	415 vdc	405 dc

(3) *Preregulator assembly (12-volt input)* (figs 2-5 and 2-6).

Point of test	Test equipment	Voltage to ground	
		Key up	Key down
Q301 emitter	VTVM	0.12 vdc	----
Q301 base	VTVM	0 volt	----
Q302 emitter	VTVM	0.46 vdc	0.7 vdc
Q302 base	VTVM	0.14 vdc	0.23 vdc

(4) *Preregulator assembly (17-volt input)* (figs. 2-5 and 2-6).

Point of test	Test equipment	Voltage to ground	
		Key up	Key down
Q301 emitter	VTVM	3.2	----
Q301 base	VTVM	3.1	----
Q302 emitter	VTVM	3.5	3.5
Q302 base	VTVM	3.2	3.1

(5) *DC Converter* (figs. 2-5 and 2-6).

Point of test	Test equipment	Voltage to ground	
		Key up	Key down
Q303 emitter	Oscilloscope	23 volts pk to pk	----
Q303 base	Oscilloscope	27 volts pk to pk	----
Q303 collector	VTVM	+0.44 vdc	----
Q304 emitter	Oscilloscope	23 volts pk to pk	----
Q304 base	Oscilloscope	27 volts pk to pk	----
Q304 collector	VTVM	+0.44 vdc	----
Point 11	Oscilloscope	29 volts pk to pk	----
Point 16	Oscilloscope	29 volts pk to pk	----

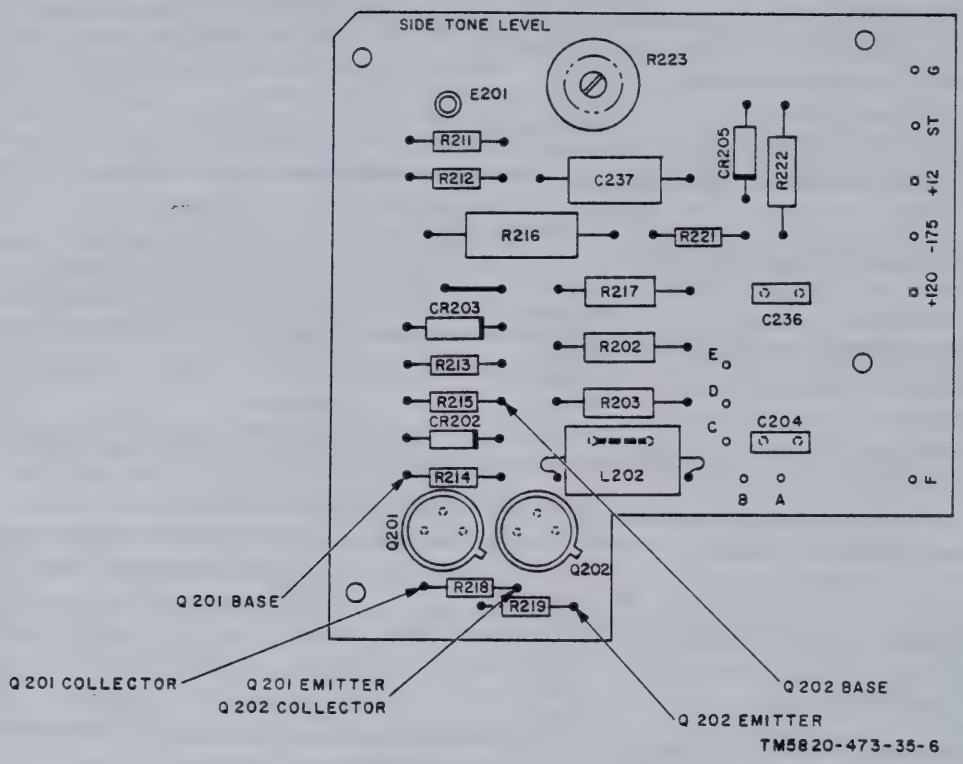
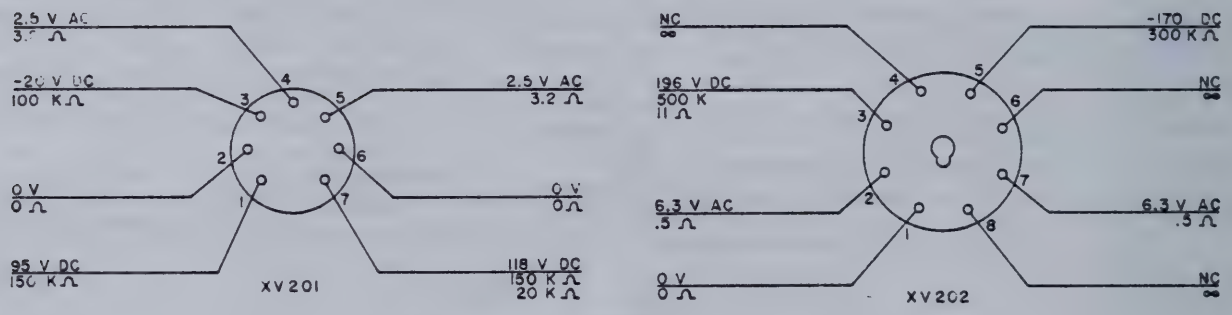


Figure 2-3. Oscillator and keyer printed circuit board test points.



NOTES:

1. VOLTAGES MEASURED WITH RESPECT TO CHASSIS GROUND.
2. VOLTAGES MEASURED WITH A VTVM.
3. NC INDICATES NO CONNECTION.
4. CAP VOLTAGE OF V02 IS 415 VDC.
5. VOLTAGE READINGS TAKEN WITH OFF-RCVR-XMIT SWITCH S301 AT XMIT, TUNE-OPERATE SWITCH S204 AT OPERATE, AND KEY UP.
6. AC VOLTAGES ARE R M S.
7. RESISTANCES MEASURED WITH 20,000 N/VOLT VOM.
8. RESISTANCES MEASURED FROM PIN TO CHASSIS GROUND.
9. RESISTANCES MEASURED WITH POWER DISCONNECTED AND 5301 AT X'MIT.
10. AT TEST POINTS WHERE TWO RESISTANCE VALUES ARE SHOWN, REVERSE LEADS TO OBTAIN BOTH READINGS.

TM5820-473-35-9

Figure 2-4. Transmitter tube socket voltage diagram.

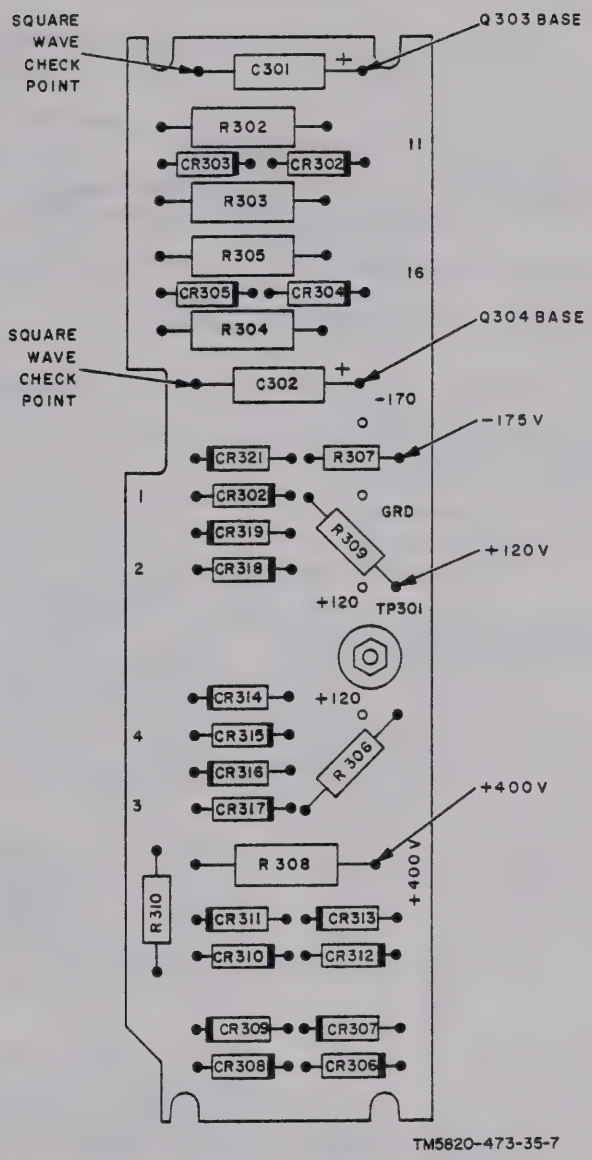


Figure 2-5. Power supply printed circuit board test points.

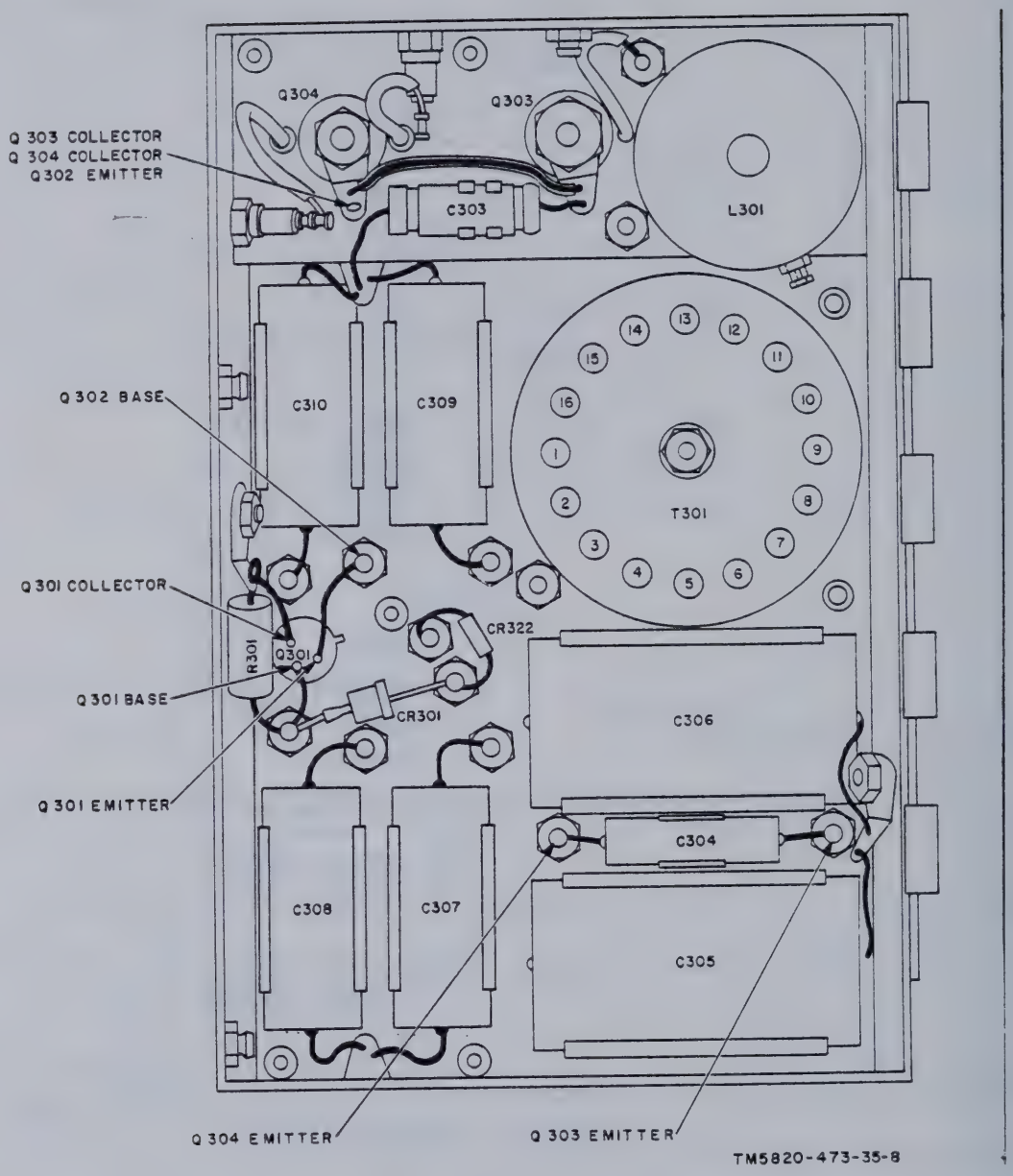


Figure 2-6. Power supply subchassis test points.

CHAPTER 3

REPAIRS AND TUNING

Section I. REPAIRS

3-1. General Parts Replacement Techniques (fig. 3-1)

Most of the parts in Radio Sets AN/TRC-77(*) can be reached easily and replaced without special procedures. Direct support is authorized replacement of all components associated with the transmitter and power supply sections. Although direct support is also authorized replacement of all components not mounted on the receiver printed circuit boards, never disconnect the wires from the printed circuit board side. The following precautions apply specifically to this set.

a. Use a pencil-type soldering iron with a 25-watt maximum capacity. This receiver is transistorized. If only ac-operated irons are available, use an isolating transformer. Do not use a soldering gun; damaging voltages can be induced in components.

b. When soldering transistor leads, solder quickly; where wiring permits, use a heat sink (such as long-nosed pliers) between the soldered joint and the transistor. Use approximately the same length and dress of transistor leads as used originally.

c. When removing defective printed circuit components, cut both leads of the component approximately 1/16 inch from the printed circuit board. Remove the component. Carefully straighten the end of the leads that extend through each hole in the printed circuit board.

Caution: **Do not touch the printed circuit foil with the soldering iron. Exert a very slight pressure and apply the tip of the hot pencil-type soldering iron to the tip of the lead.**

d. When replacing printed circuit components, use a knife to scrape the leads of the new components. Bend the component leads so that they fit snugly into the holes where the component is to be installed. Gently press the leads through the holes in the printed circuit board. Bend both leads close to the foil.

3-2. Removal and Replacement of Oscillator and Keyer Assembly Subchassis (fig. 3-2)

Perform the following removal and installation procedures to the point that allows removal and installation of the specific electronic component necessary to effect repair. Refer to figure 3-2 for parts location.

a. Removal. Remove the oscillator and keyer assembly subchassis as follows:

(1) Remove the radio set from its outer case.
(2) Remove the three screws that mount the oscillator and keyer assembly to the subchassis frame (right side of radio set while facing front panel).
(3) Unsolder and remove the jumper wire from the front part of the assembly subchassis.
(4) Remove the spring clip from the XMTR CHANNEL selector switch S201 shaft.
(5) Using a pair of long-nosed pliers, gently push the switch shaft back toward the rear of the subchassis frame until the end of the shaft clears the front partition of the subchassis frame.
(6) Remove crystal No. 6 from its socket and remove one screw located in the vacated area.

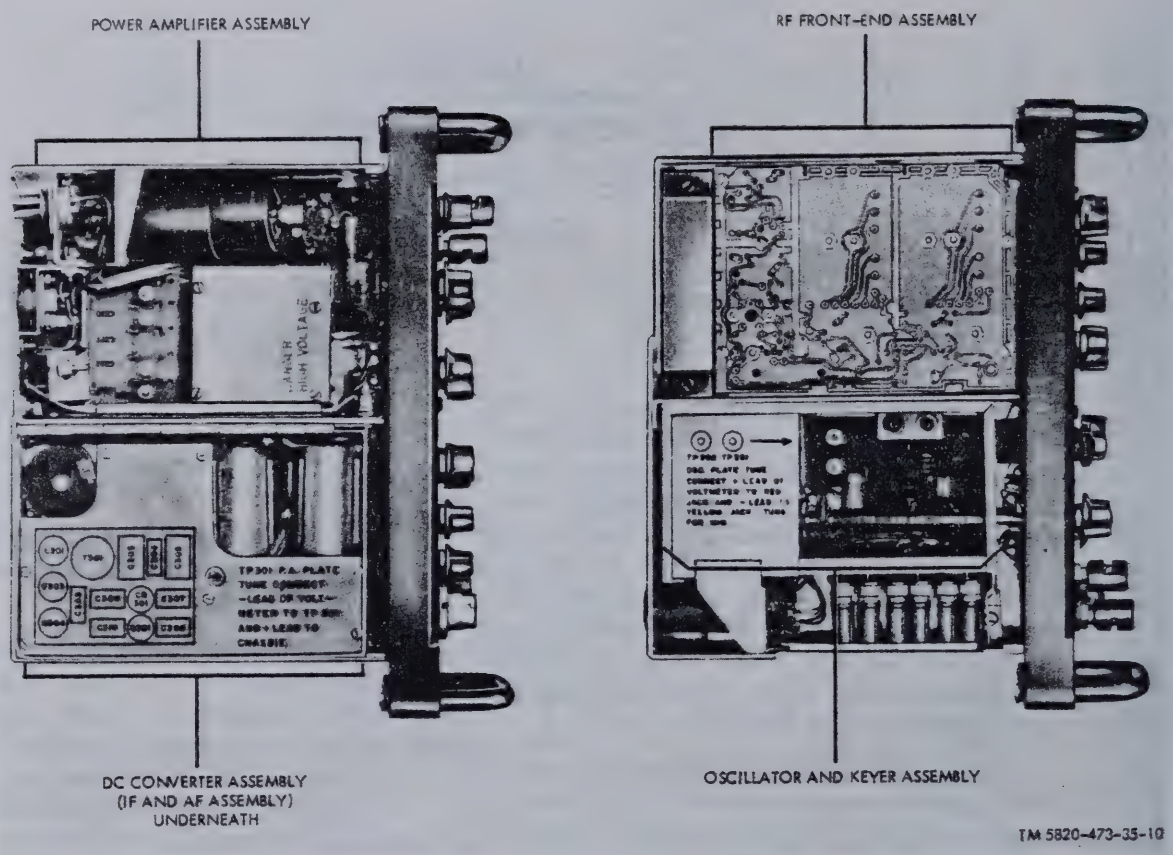


Figure 3-1. Radio set AN/TRC-77(*) major assemblies location.

(7) Remove two screws from the oscillator tube socket bracket.

(8) Remove the tube shield and tube V201 from its socket.

(9) Disconnect and tag the two wires from the vacated area near the tube socket bracket.

(10) Remove the oscillator and keyer assembly subchassis and place it in a clean work area for access to electronic components on the keyer printed circuit board.

(11) Refer to figure 3-2 for printed circuit wiring and parts location.

b. Replacement. Replace the oscillator and keyer assembly subchassis as follows:

(1) Place the oscillator and keyer assembly subchassis into its respective compartment.

(2) Insert the two screws taken from near the oscillator tube (V201) socket bracket (*a*(7) above)), the one screw removed from the crystal socket (*a*(6) above)), and the three screws taken from the oscillator and keyer assembly frame (a(2) above)); but do not final tighten.

(3) Using a pair of long-nosed pliers, gently push the switch shaft (S201) back toward the front of the subchassis frame and engage properly with the XMTR CHANNEL knob shaft. Secure the connection with the spring clip that was removed (*a*(4) above)).

(4) Reconnect the two wires that were tagged (*a*(9) above)) and reconnect the jumper wire (*a*(8) above)).

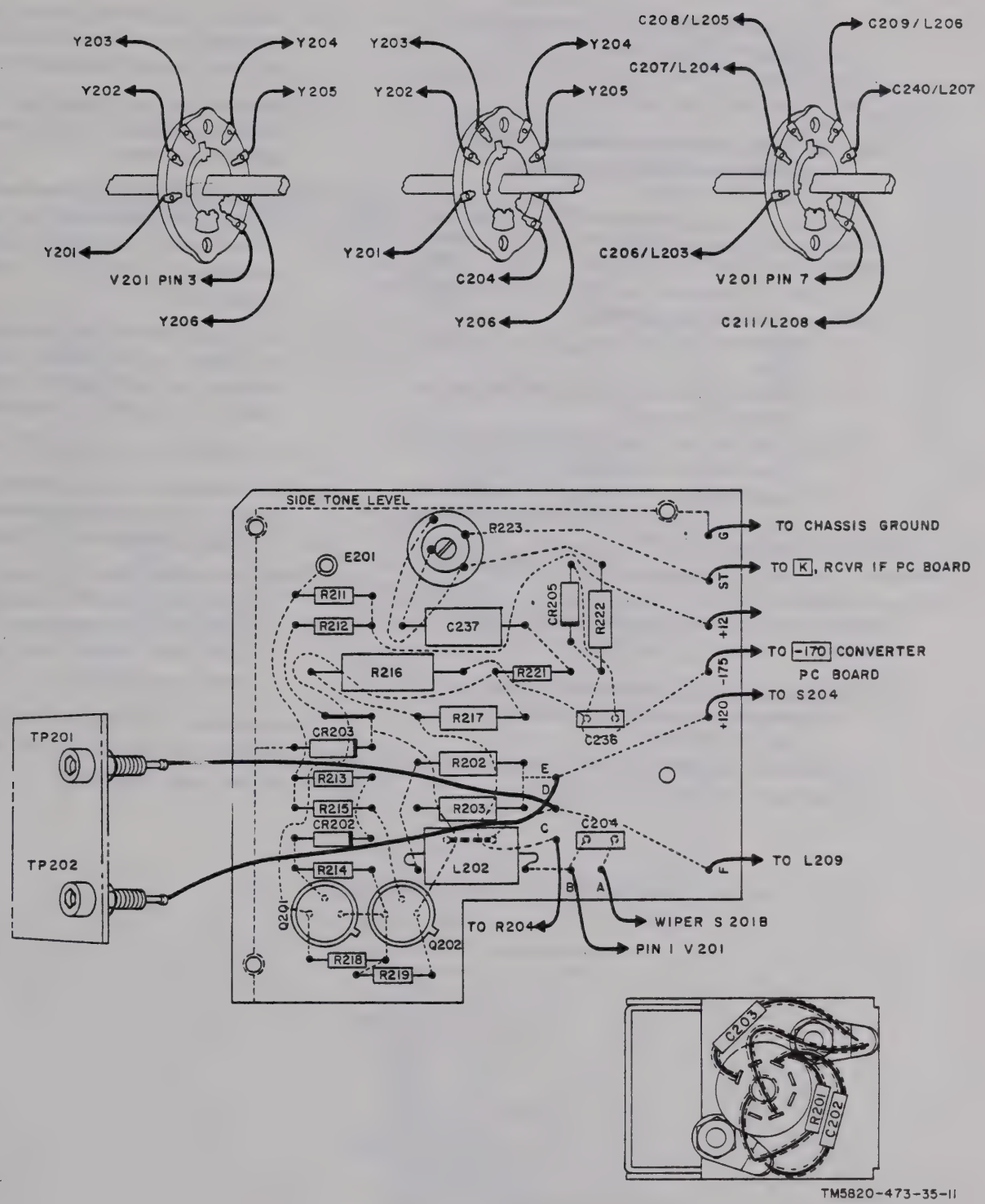


Figure 3-2. Transmitter oscillator and keyer parts location and wiring diagram.

(5) Final tighten the screws that were inserted (*b*(2) above)).
(6) Install tube V201 and the shield.
(7) Reinstall crystal No. 6.

3-3. Removal and Replacement of Power Amplifier Assembly Subchassis
(figs. 3-3 and 3-4)

Note. The power amplifier assembly subchassis cannot be removed intact as a complete assembled chassis. Remove only that hardware necessary to effect repair.

a. Removal. Remove the power amplifier assembly subchassis as follows:

(1) Remove the radio set from its outer case.
(2) Remove the oscillator and keyer assembly (para 3-2).
(3) Remove the power amplifier tube shield and tube V202.
(4) Perform the hardware disassembly to the point that allows removal and replacement of the specific electronic component necessary to effect repair.

b. Replacement. To replace the subchassis, follow the removal procedure in reverse sequence of the order indicated.

3-4. Removal and Replacement of Dc Converter Assembly Subchassis
(fig. 3-5 and 3-6)

a. Removal. Remove the dc converter assemble subchassis as follows:

(1) Remove the seven screws that hold the shield over the converter subchassis and remove the shield.
(2) Remove the five spacer nuts that support the printed circuit board to the subchassis frame.
(3) Being careful to avoid excessive strain of the leads connected to the printed circuit board, turn the board at a convenient angle for unsoldering components.
(4) To reach switching transistor Q303 or Q304 or any other components within the subchassis portion, conduct the following procedure:
   (*a*) Repeat (1) through (3) above.
   (*b*) Remove the three screws that hold the dc converter subchassis to the outside wraparound frame.
   (*c*) The subchassis will now swing up and over to allow access to both sides; thus, transistors Q303 and Q304 and other components can easily be replaced.

b. Replacement. To replace the subchassis, follow the removal procedure in reverse sequence of the order indicated.

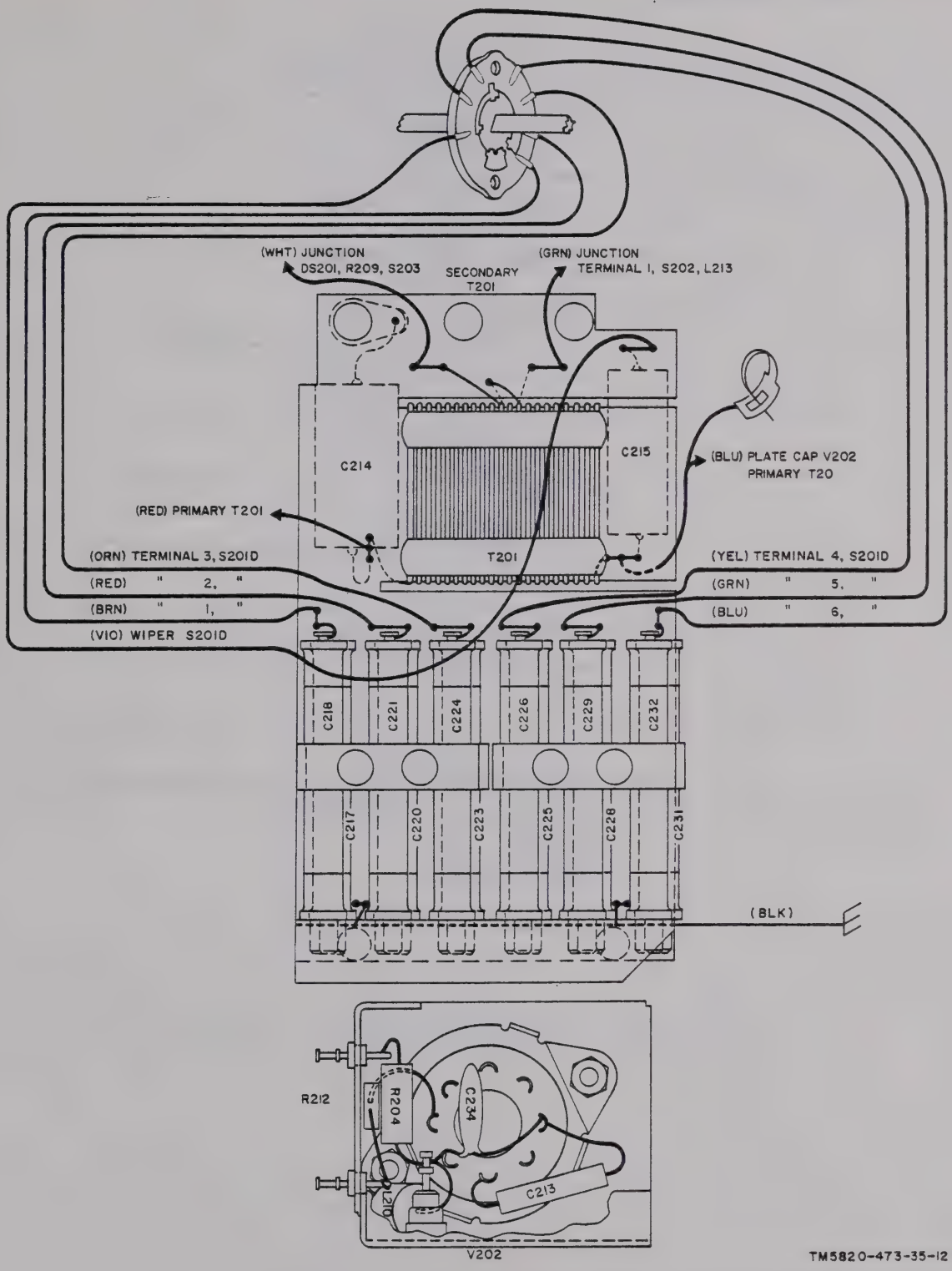


Figure 3-3. Transmitter power amplifier parts location and wiring diagram.

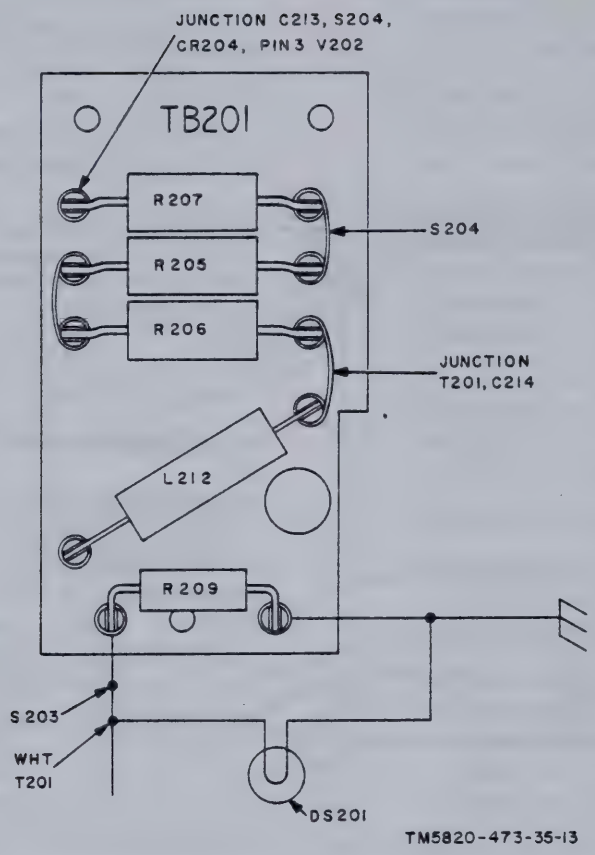


Figure 3-4. Transmitter power amplifier terminal board parts location and wiring diagram.

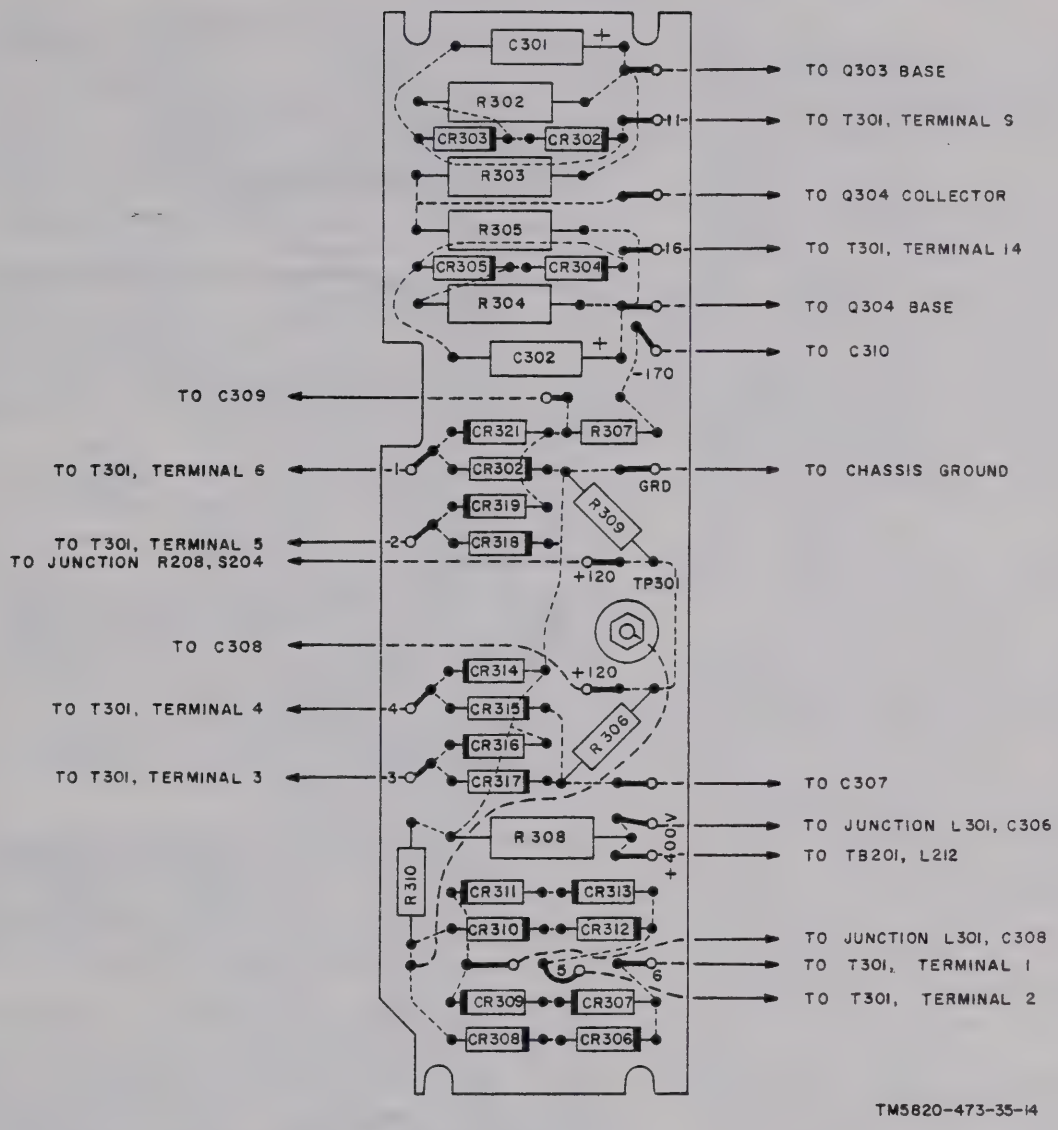


Figure 3-5. Power supply printed circuit board parts location and wiring diagram.

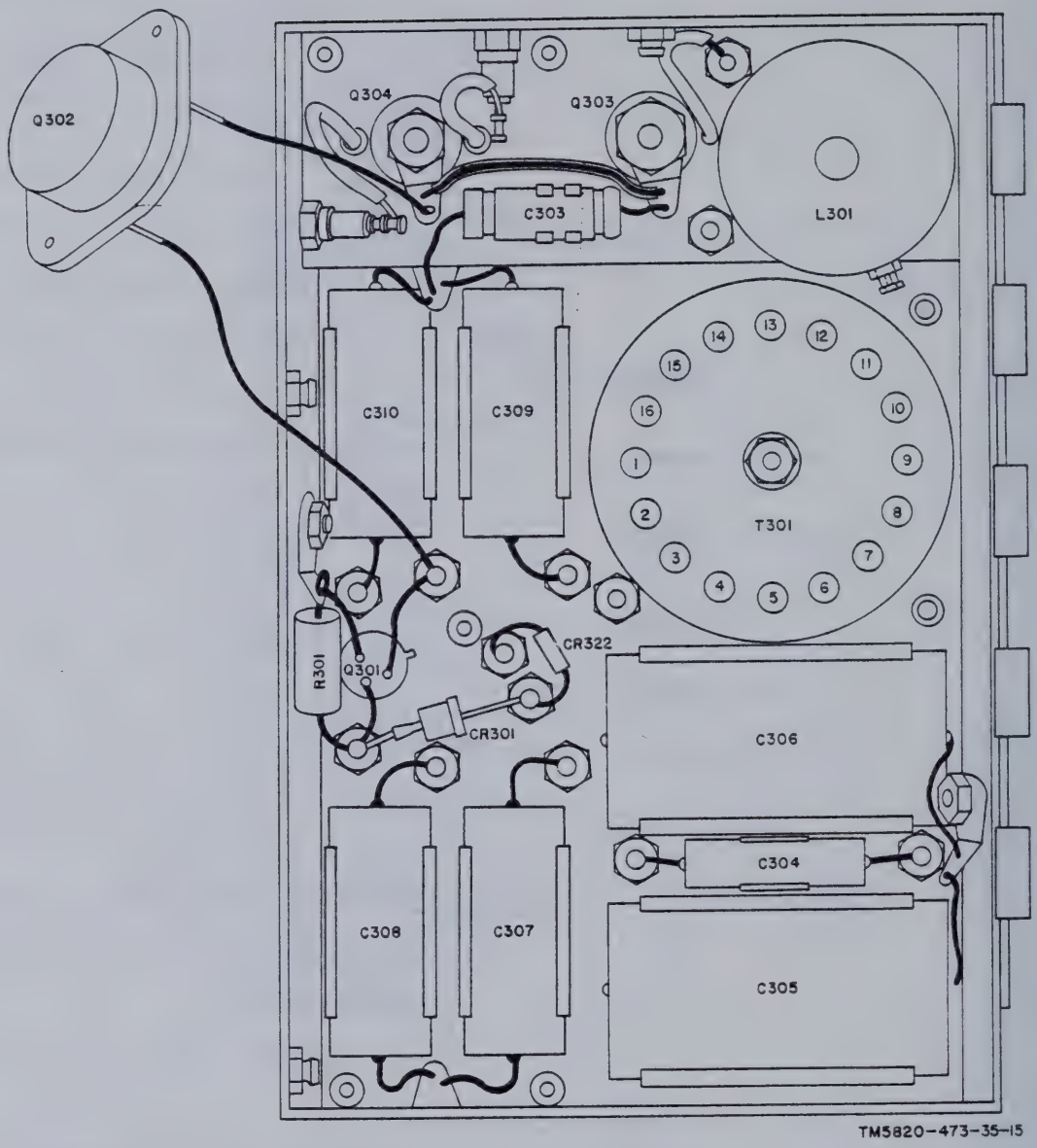


Figure 3-6. Power supply subchassis parts location and wiring diagram.

Section II. TUNING

3-5. General

After the trouble has been located and repaired, perform the tests and tuning instructions given in this section to assure that Radio Set AN/TRC-77(*) is ready to be placed into operational use.

3-6. Preliminary Testing Procedures

a. Perform voltage measurements of the oscillator and keyer assembly, power amplifier assembly and dc-to-dc converter assembly given in paragraph 2-8 before tuning the transmitter.

b. After satisfactory completion of the procedure given in *a* above, perform the tuning procedure given in paragraph 3-7.

3-7. Field Tuning Procedures, Radio Sets AN/TRC-77 and AN/TRC-77A
(figs. 3-7 and 3-8)

Note. On radio Set AN/TRC-77, a tuning tool is provided clipped to the chassis adjacent to V202. On Radio Set AN/TRC-77A, an appropriate tuning tool should be selected from Tool Kit TK-100/G or TK-115/G.

a. Transmitter Tuning. Tune the transmitter by adjusting the oscillator and power amplifier circuits accessible from the rear of the receiver-transmitter. The only test equipment required is Multimeter TS-352/U or equivalent.

Warning: **Do not use a VTVM because the VTVM common lead is connected to the instrument case and would be at +120 volts when tuning the oscillator.**

(1) *Oscillator tuning.* Tune the oscillator circuits of the transmitter as follows:

(*a*) Remove the receiver-transmitter from the case.

(*b*) Select a crystal for the desired output frequency and insert the appropriate crystal socket on the left side of the receiver-transmitter.

Note. It is convenient to arrange crystals in ascending frequency order. Since the transmitter has no multiplier stages, the crystal frequency is the same as the transmitter output frequency.

(*c*) On AN/TRC-77 units, set the appropriate tuning range link on the PA coil board (locate on the bottom of the unit, next to V202) to the correct position according to the crystal frequency as shown on the adjacent plate.

(*d*) Connect the battery on bench power supply to TEST POWER JACK J302 at the rear of the receiver-transmitter. Set the multimeter to the highest dc voltage scale and connect the positive(+) meter lead to TP202 (red) and the negative (-) meter lead to TP201 (yellow). Rotate the multimeter range switch through progressively lower voltage scales to the +3-volt scale; observe that the meter is not pinned.

(*e*) Set TUNE/OPERATE switch S204 to TUNE and support the rear of the chassis on a wooden block to prevent the switch from snapping back to the OPERATE position.

(*f*) Set the XMTR CHANNEL switch on the front panel to the channel to be tuned and set the OFF-RCVR-XMIT switch to XMIT.

(*g*) Turn the OSC TUNE coil and capacitor for the channel being tuned to full clockwise position, and tune for a dip on the meter by alternately turning the coil and capacitor in small increments in a counterclockwise direction.

(*h*) Repeat the procedures given in (*b*) through (*g*) above for all channels.

(2) *Final amplifier tuning.* Tune the final amplifier circuits of the transmitter as follows:

Note. The final amplifier is tuned with the antenna disconnected.

(*a*) Set the OFF-RCVR-XMIT switch to OFF and move the positive (+) meter lead to the chassis and the negative (-) meter lead to TP301 on the dc converter subchassis on the bottom of the unit. Connect the hand telegraph key to the KEY jack on the front panel.

Note. The transmitter should not be keyed for more than 30 seconds at one time.

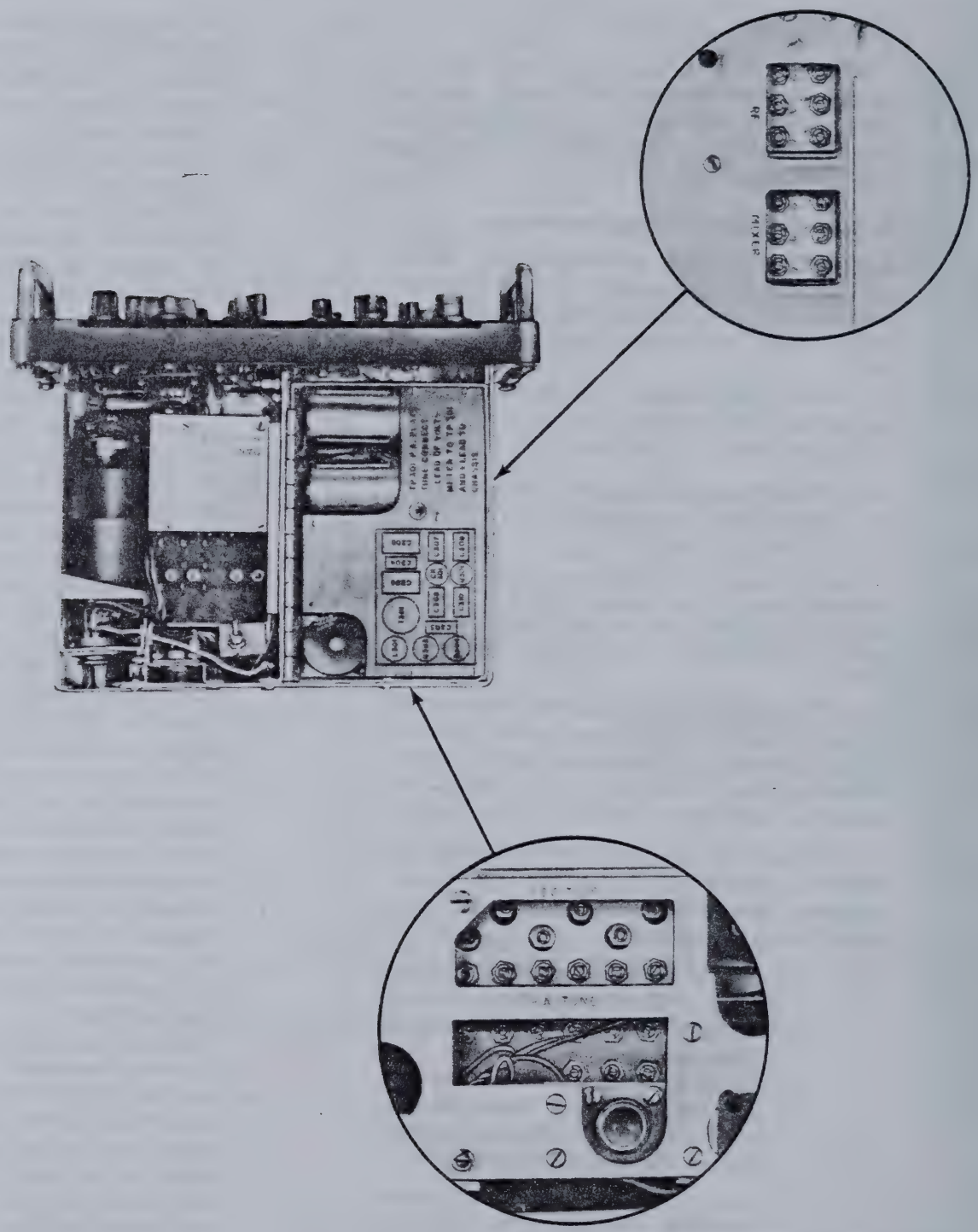


Figure 3-7. Radio Set AN/TRC-77(*) tuning controls location.

TM 5820–473–35–19

Figure 3–8. Radio Set AN/TRC–77 tuning links location.

(*b*) Turn the two PA TUNE capacitors, for the channel being tuned, to the full clockwise position. Set the OFF–RCVR–XMIT switch to XMIT and close the key. Turn the two capacitors alternately in a counterclockwise direction in small increments for a dip on the meter.

(*c*) Repeat the procedures given in (*a*) and (*b*) above for all channels.

(3) *Power output tests.* If it is necessary to check the power output of the transmitter, connect a dummy load of 30 to 50 ohm between the ANT and GND jacks on the front panel. Set the TUNE/OPERATE switch to OPERATE and measure the RF voltage across the dummy load with an RF voltmeter. For maximum power, perform the antenna tuning portion of the operating procedures contained in TM 11–5820–473–12. Compute the power by the use of the following formula:

$$P = \frac{E^2}{R}$$

b. Receiver Tuning. Field tuning of the receiver is accomplished by tuning the RF and mixer circuits which are accessible at the right-hand side of the unit. The only test equipment required is a Signal Generator AN/URM–25–F. Tune the receiver as follows:

(1) Select a crystal 455 kc above the receiver channel frequency desired and insert it into an appropriate local oscillator socket at the right rear of the receiver-transmitter.

(2) Set the RCVR CHANNEL switch to the channel being tuned.

(3) Set the AM–CW switch to AM.

(4) Set the RF GAIN and VOL controls to their maximum clockwise positions.

(5) On AN/TRC–77 units, set the receiver mixer and RF tuning links on the receiver front end circuit board as follows:

(*a*) Looking from the rear of the unit, the six links closest to the viewer are the mixer links; those farthest away are the RF links. There is one RF link and one mixer link for each channel, numbered left to right.

(*b*) For channels receiving frequencies from 3 to 3.8 megacycles, the RF and mixer links should be in the position closest to the rear of the unit.

(*c*) For channels receiving frequencies from 3.8 to 8 megacycles, the RF and mixer links should be in the position closest to the front of the unit.

Caution: **Before connecting the signal generator to the radio set, make sure the hand telegraph key is disconnected from the front panel.**

(6) Connect the signal generator to the ANT and GND terminals on the front panel and tune it to the same frequency as the receiver channel being tuned.

(7) Set the OFF–RCVR–XMIT switch to RCVR.

(8) Set the signal generator for a 30-percent modulated, 1-kilocycle signal and increase the output level until a good signal is heard at the headset.

(9) Adjust the RF and mixer variable capacitors for the channel being tuned to give the maximum output in the headphones.

(10) Reduce the signal generator output level as the RF and mixer capacitors are adjusted until the circuits are peaked. With the circuits peaked, a 1.0-microvolt output from the signal generator should produce a strong tone in the headset.

(11) Repeat the procedures given in (5) through (10) above for all channels.

CHAPTER 4

GENERAL SUPPORT MAINTENANCE

Section I. TROUBLESHOOTING

4-1. General Maintenance Information

General Support troubleshooting procedures cover those procedures applicable to the receiver front end assembly printed circuit board and the IF and af assembly printed circuit board of the receiver section. The troubleshooting information is compatible for both the AN/TRC-77 and AN/TRC-77A radio sets. The general troubleshooting techniques established in direct support are to be utilized during general support troubleshooting. In addition to the troubleshooting chart (para 4-2) and minor test point measurements (para 4-5), the signal substitution techniques and procedures (para 4-3) have been incorporated into general support troubleshooting to further aid in sectionalizing, localizing, and isolating within the receiver section of the radio set.

4-2. Receiver Section Troubleshooting Chart

Before using the following troubleshooting chart, refer to the direct support troubleshooting chart to eliminate troubles associated with those components not presented in this chart; proceed with item 1 of this chart.

Item	Indication	Probable trouble	Procedure
1	No output	Defective audio stage Q53, Q54, or Q55.	Make voltage measurements to determine operating bias of Q53, Q54, and Q55 (para 4-5). Perform signal substitution test (para 4-3).
		Defective headset	Check headset by substitution
		Defective PHONES jack J51	Check PHONES jack J51 and connections.
		Open coupling capacitors	Check (by bridging) capacitors C65, C61, and C59.
		Defective volume control or poor connection to printed circuit board.	Check VOL control R69 and associated wiring.
		Defective transformer T53	Check transformer T53 for open or shorted windings.
		Open or shorted bypass capacitors	Check capacitors C60, C64, C65, and C66.
		Defective detector stage	Perform signal substitution test (para 4-3). Check diodes CR54 and CR53.
		Defective transformer T52	Check transformer T52 for open or shorted windings.
		Open bypass capacitors	Check capacitors C58 and C57 by bridging.
		Defective diode CR55	Check diode CR55.
		Defective agc network	Perform voltage checks of AGC transistor Q57 (para 4-5).

Item	Indication	Probable trouble	Procedure
		Defective IF or RF stages	Perform signal substitution tests (para 4–3).
		Defective if. stages Q3, Q51, and Q52.	Perform voltage checks of if. stages Q3, Q51, and Q52 (para 4–5).
		Rf stages defective	Perform voltage checks of rf stages Q2, Q4, and Q1.
		Defective mixer	Check transistor Q2.
		Defective filter FL1	Check filter FL1.
		Defective coupling coil L2	Check coil L2 for open or shorted winding.
		Open coupling capacitor C28	Check capacitor C28.
		Defective local oscillator	Perform voltage checks of transistor Q4 (para 4–5).
		Open coupling capacitor C34	Check capacitor C34.
		Defective filter FL2	Check filter FL2.
		Shorted or open bypass capacitors.	Check capacitors C37, C39, C40, and C41.
		Open feedback capacitor	Check capacitor C35.
		Open coupling capacitor	Check capacitor C36.
		Inoperative RF amplifier stage	Perform voltage checks of transistor Q1 (para 4–5). Check RF GAIN control resistor R91.
		Defective OR gate	Check diodes CR56 and CR57.
		Open or poor antenna connection	Check antenna connection.
		Open RF input capacitor	Check input capacitor C1.
		Defective bias network	Check capacitor C2, diode CR1, and resistor R1.
2	No RF GAIN control with AM–CW switch S51 at CW.	Defective switch S51	Check switch S51 for mechanical operation and electrical connections.
3	Audible signals varies in volume while AM–CW switch is at AM.	Defective switch	Check S51.
		Defective OR gate	Check diodes CR56 and CR57.
		Defective voltage-dividing network	Check capacitors C75 and C42 and resistors R21 and R89.
		Defective aGC stage	Perform voltage checks of Q57 (para 4–5).
4	Am mode signals are heard; cw signals are not.	Defective bFO stage	Perform voltage checks of Q56.
		Defective mode selection switch	Check AM–CW mode selection switch S51.
		Defective diode limiters	Check diodes CR51 and CR52.
5	Poor selectivity	Defective transformer T1, filter FL1, or filter FL2.	Check transformers T1 and filters FL1 and FL2.
		High resistance solder connections, high resistance ground returns.	Check for cold solder joints in the RF and IF stages. To test ground returns, use a jumper wire to parallel the suspected ground return lead being checked.
		Improper receiver alignment	Realign receiver (para 4–11).
6	Oscillations howling, squealing.	Filter FL1, improperly terminated	Check filter FL1 for proper termination (1,500 ohms). Check solder connections and associated components for proper values.

Item	Indication	Probable trouble	Procedure
		Poor filtering of IF signal in detector stage.	Check filter components C57, R66, and C60.
		Loss of neutralization in first IF amplifier stage.	Check C21 and C32. Perform voltage checks of transistor Q3 (para 4-5).
		Defective filter FL2	Check filter FL2.
		Defective capacitor CZr	See that the RF signal is feeding through capacitor C28 to the base of the mixer Q2.
		Defective coil L2	Check coil L2.
		Defective filter FL1	Check filter FL1. Conduct a band-pass test on filter FL1 to be sure that IF bandwidth of 6kc at 6 db down and 11kc at 60 db down exists.
		Defective capacitor C35	Check capacitor C35.

4-3. Signal Substitution

a. General. Signal substitution procedures help to localize troubles to a stage of the receiver. An externally generated signal is substituted for the signal normally present in each stage. In the following tests, ground one side of the RF signal generator or af signal generator to the receiver chassis and connect the other side to the receiver test point indicated. To avoid unnecessary troubleshooting, be sure to perform the test outlined in *b* below before proceeding to the other tests.

Note. The printed circuit board is covered with a protective epoxy coating. Use sharp pointed probes with test equipment to puncture the epoxy coating and make good electrical contact.

b. Sectionalization Test (fig. 7-6). The purpose of this test is to eliminate entire sections within the receiver as possible sources of trouble. By injecting a signal at critical points and listening for an audible indication on the headset, a trouble can be isolated to the audio, intermediate, or the radiofrequency sections. For the purpose of this test, the power supply (or battery) is known to be in good condition and the headset is known to be functioning properly. Conduct the signal substitution sectionalization test as follows:

Note. Refer to figure 7-6 for location of test points.

(1) Set the audio oscillator to produce an audio output signal of 1,000 cycles at 1 millivolt.

(2) Plug the headset into PHONES jack J51.

(3) Apply the signal to test point TP52. Listen for the signal in the headset. If no signal is heard, perform the audiofrequency tests given in *c* below.

(4) Set the RF signal generator to produce a 1,000-cycle modulated output of 455 kc at 1 millivolt.

(5) Apply the signal to test point TP1. Listen for the signal in the headset. If no signal is heard, perform the intermediate frequency tests as outlined in *d* below. If a signal is heard, perform the radiofrequency tests given in *e* below.

c. Audiofrequency Tests. Start these tests at the output of last audio stage Q55 and work back toward first stage Q53.

(1) Set the af signal generator to produce an output signal of 1,000 cycles at 1 millivolt.

(2) Plug the headset into PHONES jack J51.

(3) Apply the signal to the points indicated in the following audiofrequency signal substitution chart. Refer to the schematic diagram (fig. 7-6) for electrical orientation.

d. Intermediate-Frequency Tests. Start the tests at the output of the last IF stage and work forward toward the first IF stage.

(1) Set the RF signal generator for a 1,000-cycle modulated output of 455 kc at 1 millivolt.

(2) Plug headset into PHONES jack J51.
(3) Apply the signal to the various test points called out in the following signal substitution chart. Refer to the schematic diagram for electrical reference with respect to signal paths.

e. Radiofrequency Tests. Start the radiofrequency tests at mixer stage Q2 and work back toward the antenna.

(1) Set the RF signal generator for a 1,000-cycle modulated output of from 3 to 8 mc at 100 microvolts (μv).
(2) Vary the RF to match the tuning components within the mixer, local oscillator, and RF amplifier stages of the channel selected for reception.

f. Signal Substitution Troubleshooting Charts.

Signal frequency	Connection to	Possible trouble
1 kc	Q55 collector	Defective transformer T53, headset, or phone jack J51.
1 kc	Q55 base	Defective transistor Q55, shorted C66, open R78.
1 kc	TP52	Open coupling capacitor C59, defective transistor Q53 or volume control R69. Open coupling capacitor C61.
455 kc modulated 1 kc	TP51	Defective diodes CR53 and CR54; open agc set R64, shorted bypass capacitor C58 or C57. Defective diode CR55.
455 kc modulated 1 kc	Q52 base	Defective transistor Q52, open transformer T52, associated bias network.
455 kc modulated 1 kc	TP1	Defective neutralization network C31 and C23. Open coupling capacitor C51; defective transistor Q51; defective transformer T51.
455 kc modulated 1 kc	Q2 collector	Open ladder filter FL1, defective transistor Q3, shorted capacitor internally wired in T1, open coupling transformer T1.

4–4. Isolation

Besides conventional continuity measurements, component substitution techniques, and direct support isolation techniques, general support isolation incorporates the use of the minor test points (para 4–5).

4–5. Minor Test Points

a. General. The minor test points for general support troubleshooting are incorporated in the two voltage charts (*c*(1) and (2) below) and serve to aid in isolating troubles to components within the receiver section of radio sets AN/TRC–77(*). The RF amplifier, local oscillator, mixer, and first IF amplifier stages are covered in the receiver front end voltage chart (*c*(1) below) which encompasses the minor test points for the radiofrequency section of the receiver. The second and third IF amplifiers, detector, three audio stages, bfo, and agc stages are covered in the IF and af voltage chart (*c*(2) below) which provides the minor test points for the intermediate and audiofrequencies of the receiver.

b. Conditions for Measurements.
(1) Remove the radio set from its outer case.
(2) Connect the receiver to its normal headset load or an equivalent impedance.
(3) Place a jumper wire (alligator clips) across bfo capacitor C68 so that all the rotor and stator plates are shorted to ground and bfo oscillator Q56 is disabled.
(4) Using an electronic-type multimeter (vtvm), measure 12 volts at test points J and L (fig. 7–6) to validate the following values.
(5) Set OFF–RCVR–XMIT switch S301 to RCVR.
(6) Set AM–CW switch S51 to AM.
(*a*) Connect an electronic-type multimeter (vtvm) at test point TP53
(*b*) Adjust AGC SET resistor R64 for 5 volts.

c. Voltage Charts.

Note. For all measurements, use an electronic-type voltmeter (vtvm). Voltages are measured between test points indicated in chart and ground.

(1) *RF front end voltage chart* (fig. 4–1).

Note. Set the AM–CW switch to CW and RF GAIN control R91 (fig. 7–6) fully clockwise.

Test point	Voltage (dc)
Q1 base	5.4
Q1 collector	0
Q1 emitter	5.6
Q1 bias reference	6.9
Q2 base	5.4
Q2 collector	0.75
Q2 emitter	5.7
Q2 bias reference	7.9
Q3 emitter	5.4
Q3 collector	0
Q3 bias reference	10.5
Q4 bias reference	7.1
Q4 base	3.7
Q4 emitter	3.7
TP1	5.6
RF agc	5.3
IF agc	5.3

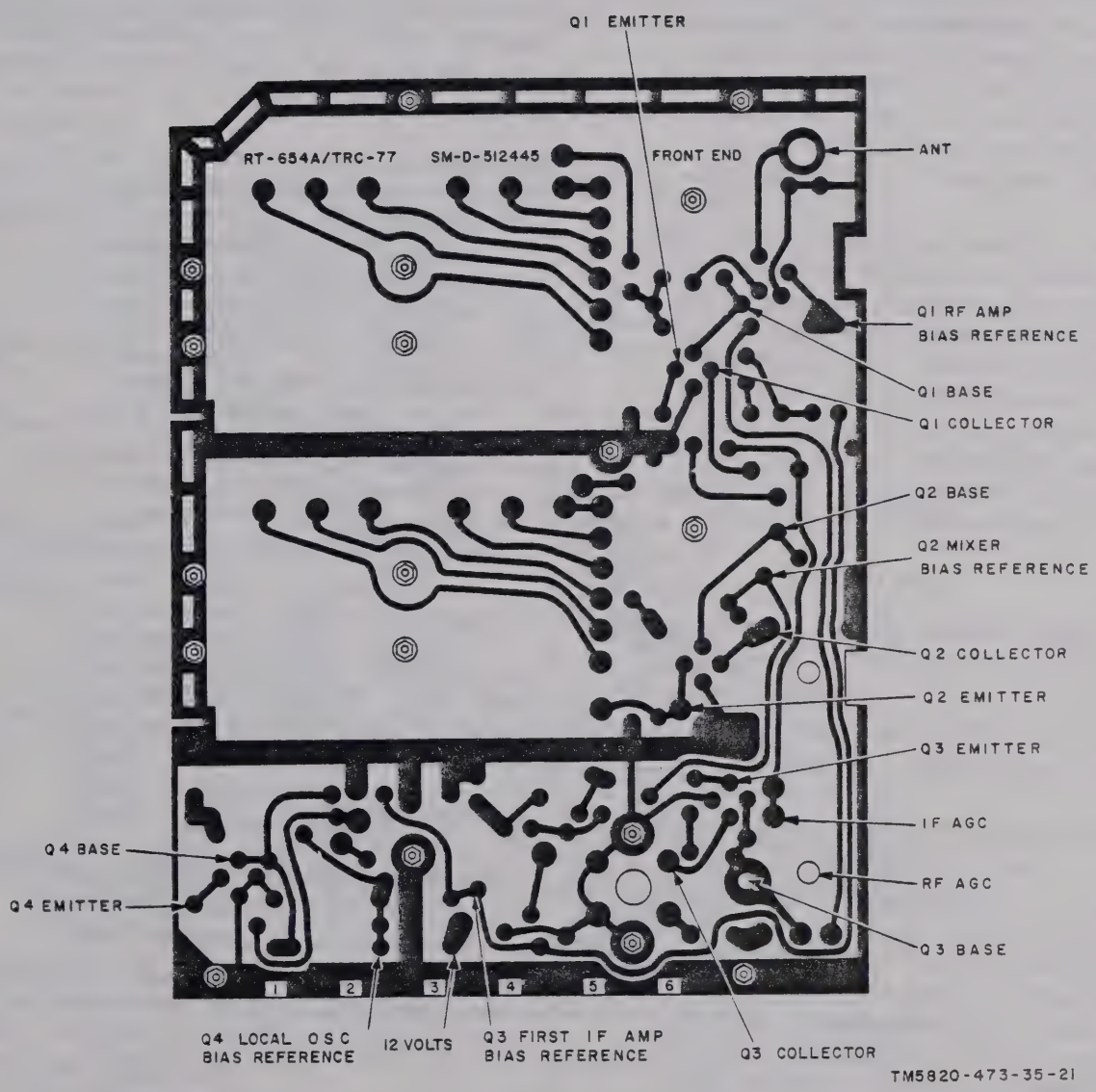


Figure 4–1. RF front end printed circuit board test points.

(2) *IF and AF voltage chart.* (fig. 4–2).

Note. Set AM-CW switch S51 to CW. Connect a vtvm across RF GAIN control resistor R91 at test point C (fig. 7–6) to ground. Adjust the RF GAIN control for a meter reading of 5.1 volts dc.

Test point	Voltage (dc)
Q51 bias reference	9.0
Q52 bias reference	11.0
Q56 bias reference	9.6
Q51 emitter	5.5
Q51 base	5.3
Q51 collector	0
Q52 emitter	6.5
Q52 base	6.2
Q52 collector	0
Q53 emitter	10.0
Q53 base	9.9
Q54 emitter	10.6
Q54 base	10.5
Q54 collector	3.4
Q55 emitter	6.6
Q55 base	6.4
Q55 collector	0.5
Q56 emitter	5.8
Q56 base	5.6
Q57 emitter	0.47
Q57 base	1.05
Q57 collector	5.1

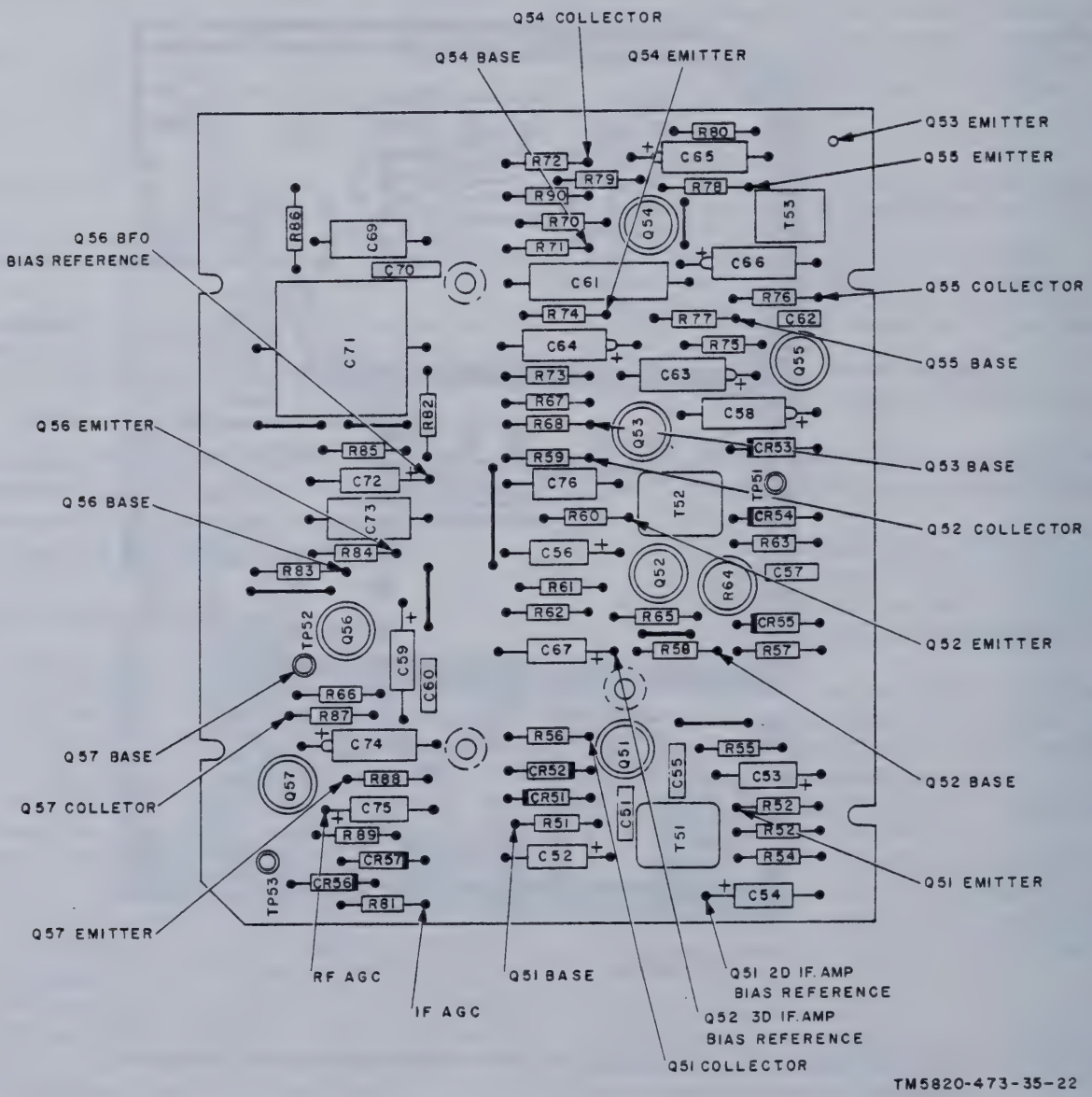


Figure 4–2. IF and af printed circuit board test points.

Section II. GENERAL SUPPORT REPAIR PROCEDURES

4–6. General

Repair of the receiver front end printed circuit board assembly and the receiver IF and af printed circuit board assembly, and the removal and replacement of components located on these printed-circuit boards are performed at general support maintenance facilities.

4–7. Printed Circuit Board Repairs

Caution: **To avoid damaging the printed circuit when repairing the receiver printed circuit assemblies, carefully follow the procedures described below.**

a. Removal of Defective Printed Circuit Components.

(1) Cut both leads of the component approximately 1/16 inch from the printed circuit board. Remove the component.

(2) Carefully straighten the end of the leads that extend through each hole in the printed circuit board.

Caution: **Do not touch the printed circuit foil with the iron.**

(3) Exert a very slight pressure and apply the tip of the hot pencil-type soldering iron to the tip of the lead.

b. Replacement of Printed Circuit Components.

(1) Use a knife to scrape the leads of the new components.

(2) Bend the component leads so that they fit snugly into the holes where the component is to be installed. Gently press the leads through the holes in the printed circuit board. Bend both leads close to the foil.

4–8. Removal and Replacement of Receiver Front End Assembly (fig. 4–3)

To replace the electronic components mounted on the receiver front end printed circuit board, remove and install the receiver front end chassis as follows:

a. Removal.

(1) Remove the radio set from its outer case.

(2) Remove three screws that are on the outside edge of the dc converter assembly (side opposite from the hinge in the dc converter chassis) and swing the dc converter out and over as far as possible.

(3) Disconnect plug P51 from jack J1.

(4) Disconnect the antenna lead from the ANT connection on the printed circuit side of the front end assembly.

(5) Remove five mounting screws holding the receiver front end chassis to the main chassis. Three screws are accessible from the outside main wraparound and two from the partition at the keyer circuit board assembly.

(6) Using a screwdriver, carefully pry up the front of the front end chassis and then the back of the chassis, alternating between the two in small increments until the assembly subchassis slides out of the main chassis.

(7) Retain the metal partition shield. Retain the nylon coupling block associated with the front knob and shaft of RCVR CHANNEL selector switch S1.

b. Replacement.

(1) Install the nylon coupling block on the shaft protruding from the front end chassis.

(2) Be sure the metal partition is mounted next to the oscillator and keyer assembly.

(3) Set RCVR CHANNEL selector switch S1 to the channel 6 position.

(4) Hold the front end chassis in a position (slight angle with shaft side down) so as to line up the nylon coupling block with the vertical slot keyway presented by the shaft of RCVR CHANNEL selector switch S1; carefully work the chassis into the main frame by prying gently at the back and front ends of the front end chassis.

(5) When the front end chassis is properly seated, install the five screws removed in *a*(5) above.

(6) Reconnect the antenna lead to the ANT terminal and plug P51 to jack J1.

(7) Swing the dc converter chassis back into normal operating position and secure with three screws removed in *a*(2) above.

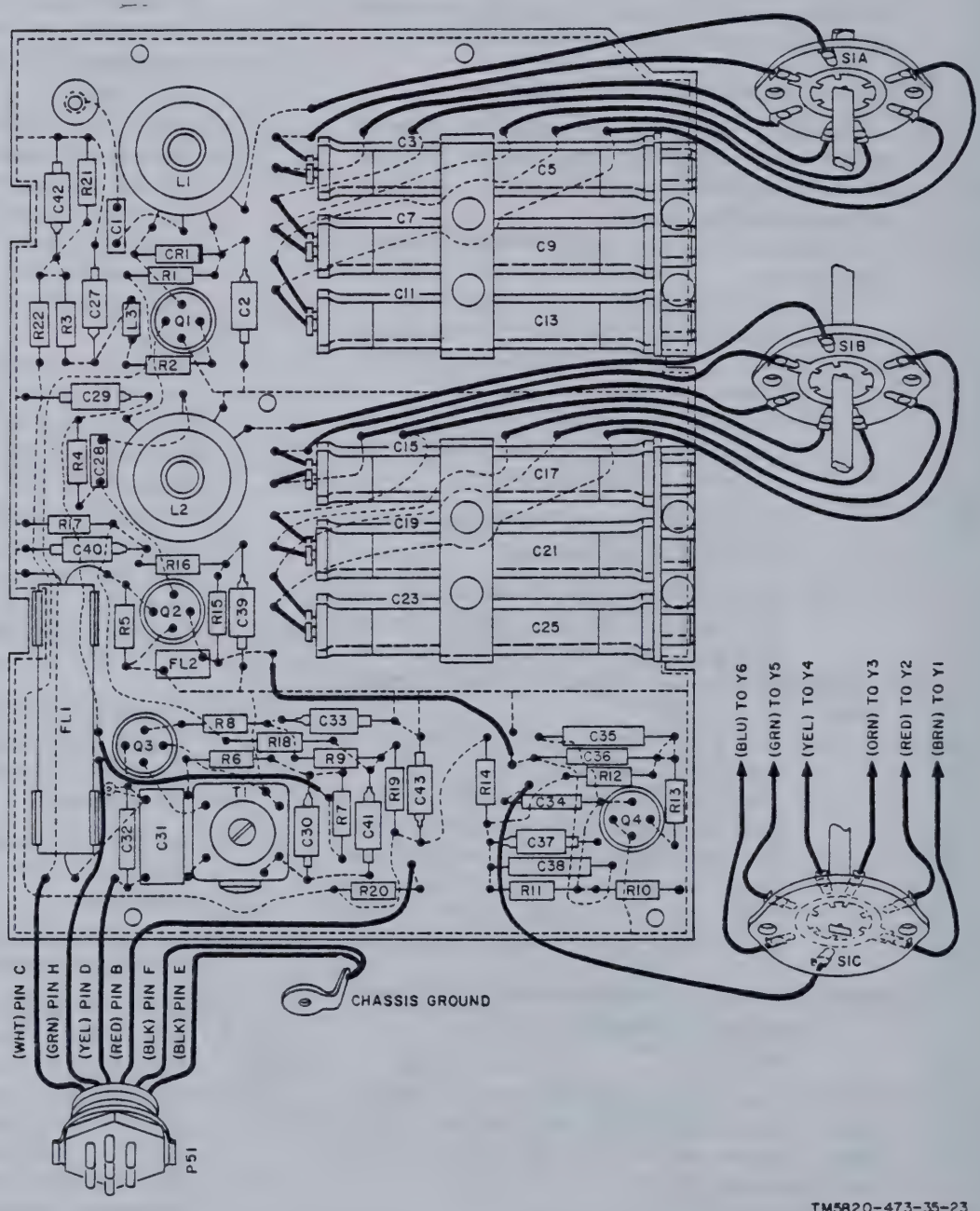


Figure 4-3. RF front end printed circuit board parts location and wiring diagram.

4–9. Removal and Replacement of IF and Af Assembly
(fig. 4–4)

Caution: **Do not remove the IF and af chassis for small repairs and troubleshooting.**

To replace the electronic components mounted on the IF and af printed circuit board, remove and install the IF and af assembly chassis as follows:

a. Removal.

(1) Remove the receiver front end assembly chassis as detailed in paragraph 4–8.

(2) Remove two screws from the main chassis wraparound.

(3) Using a long screwdriver, reach through the holes in the left side of the main chassis wraparound, under transmitter final amplifier V202 component board, and remove two screws in the partition.

(4) Remove the subchassis, being careful not to damage wire connections to the printed circuit board.

b. Replacement.

(1) Install the subchassis. Install the two screws removed in *a*(3) above and the two screws removed in *a*(2) above.

(2) Install the receiver front end chassis as detailed in paragraph 4–8*b*.

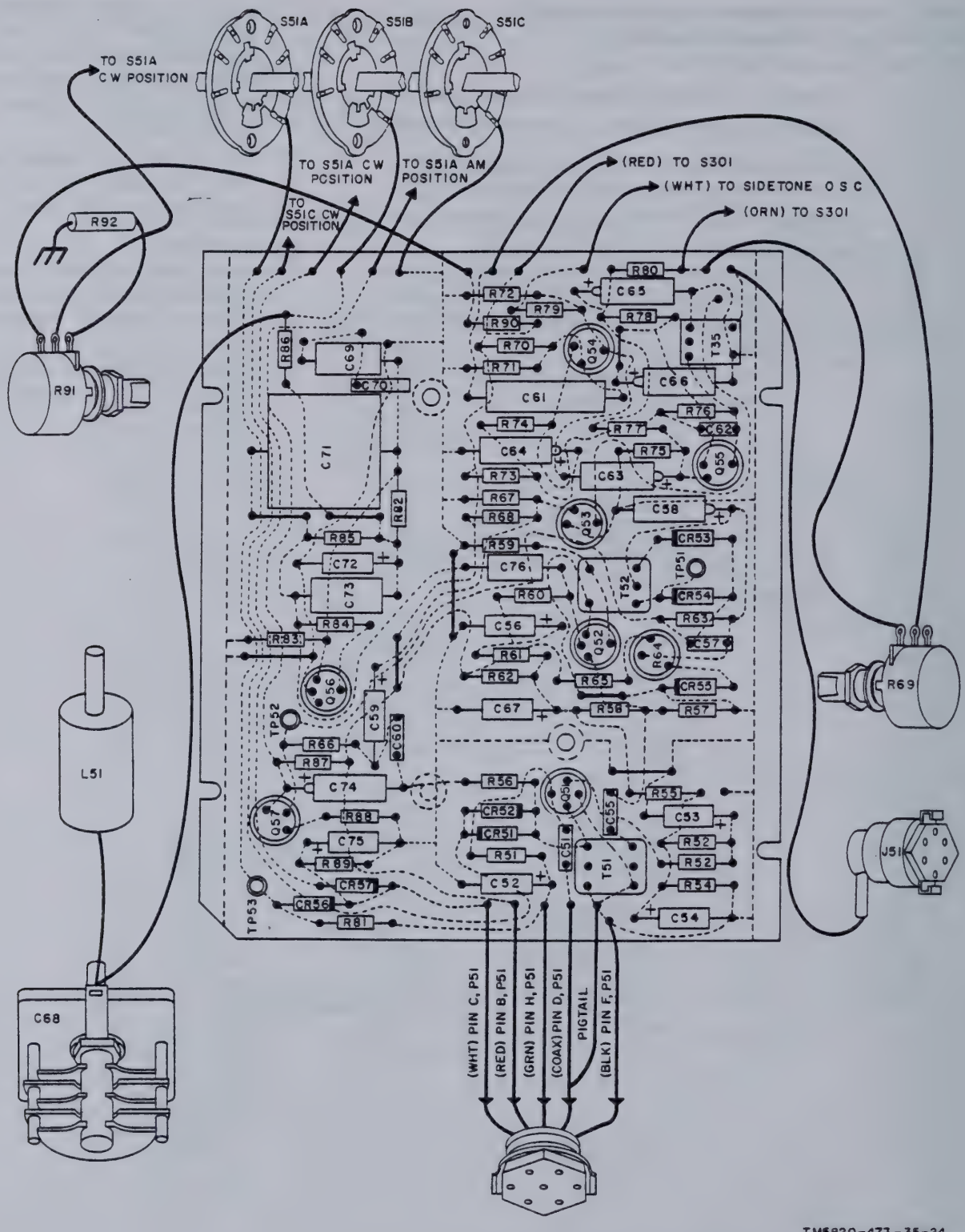


Figure 4-4. IF and af printed circuit board parts location and wiring diagram.

Section III. GENERAL SUPPORT ALIGNMENT PROCEDURES

4-10. General

a. General support alignment procedures consist of testing and aligning the receiver section to achieve maximum selectivity, sensitivity, and stability of the received radio signal. The tests and the alignment procedures in paragraphs 4-11 through 4-23 must be conducted in that order to assure proper alignment.

b. Prepare the radio set for testing and alignment by conducting the procedures detailed in paragraph 2-5.

c. Refer to figure 4-5 for location of alignment controls.

d. The following test equipment and tools are required.

Test equipment	Technical manual	Common name
Multimeter ME-26B/U	TM 11-6625-200-12	Vtvm.
Multimeter TS-352/U	TM 11-5527	Current meter.
Oscilloscope AN/USM-140A	TM 11-6625-535-15	Oscilloscope.
Electron Tube Test Set TV-7/U	TM 11-6625-274-35	Tube tester.
Output Meter TS-585D/U	TM 11-5017	Audio power meter.
Electronic Voltmeter ME-30B/U	TM 11-6625-320-12	Vtvm.
Transistor Test Set TS-1836/U	TM 11-6625-539-15	Transistor tester.
Signal Generator SG-299/.U	TM 11-5134-15	Square wave generator
RF Signal Generator AN/URM-25F	TM 11-5551E	RF signal generator.
Wattmeter AN/URM-120	TM 11-6625-446-15	Wattmeter.
Electronic Voltmeter AN/URM-145	TM 11-6625-524-14	RF voltmeter.
Frequency Meter AN/USM-26	TM 11-5057	Counter.
Audio Oscillator TS-382/U	TM 11-6625-270-12	Audio oscillator.
Tool Kit TK-100/G	SB 11-549	Toolkit.

4-11. Am. Sensitivity Test

Note. At room temperature, normal receiver sensitivity will be 1 microvolt for 10 db (S+N) in the am. mode. At high (150° F) and low (-40° F) extremes, the sensitivity will decrease to approximately 2 microvolts.

a Connect the RF signal generator to the ANT and GND terminals

b. Conduct the tuning procedures given in paragraph 3-7.

c. Increase the input RF signal to approximately 1.0 microvolt. The signal should be modulated 30 percent at 1 kc.

d. Connect the audio power meter to the PHONES jack.

e. Adjust VOL control R69 so that the audio output is 1 milliwatt.

f. Turn the 1-kc modulation off at the signal generator.

g. The audio output should decrease 10 db below 1 milliwatt (noise level). If the output level drops less than 10 db, increase the input signal and repeat *c* and *e* above. If the output level drops more than 10 db, decrease the input signal and repeat *c* and *e* above.

h. Record the input signal level where the output level with no modulation drops 10 db below the 1-milliwatt output level with the 30-percent modulation.

4-12. Cw Sensitivity Test

Note. At room temperature, receiver sensitivity in the cw mode will be 0.4 microvolt for 10 db (S+N)/N. At the temperature extremes, the sensitivity will decrease to about 1 microvolt.

a. Set selector switch S51 to CW, and RF GAIN control R91 maximum.

b. Connect the audio power meter to the PHONES jack.

c. With no input signal, adjust VOL control R69 for an audio output (noise) 10 db below 1 milliwatt.

d. Connect the RF signal generator to the ANT and GND terminals.

e. Increase the input signal until the audio output reaches 1 milliwatt; at the same time, adjust BFO PITCH control C68 for maximum audio output.

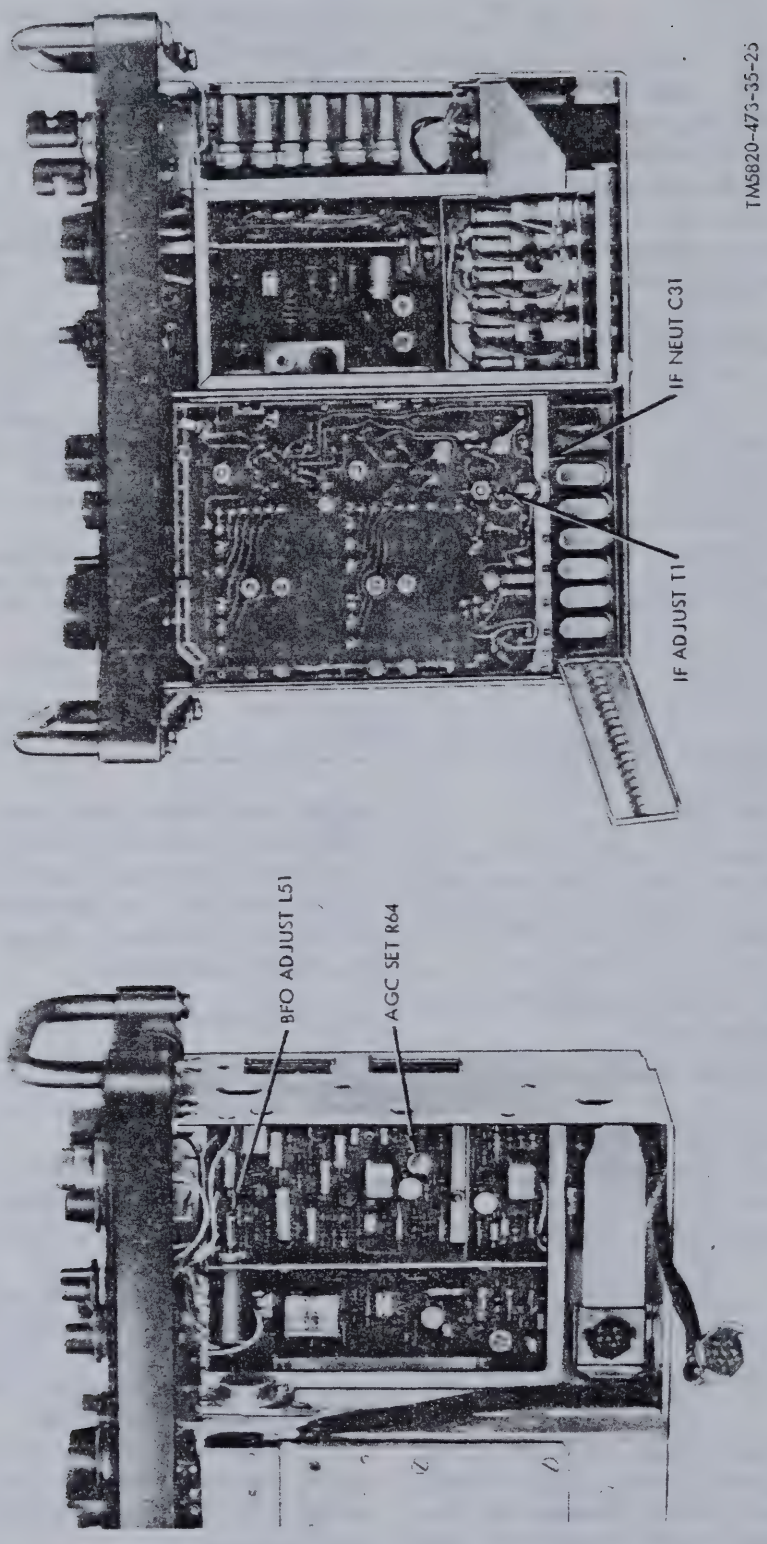


Figure 4-5. Receiver alignment controls location.

f. Recheck audio output level with no signal to make sure that it is 10 db below 1 milliwatt. Adjust VOL control R69 if necessary.

g. Record RF signal generator input level which yields the 10-db signal plus noise-to-noise ratio with 1-milliwatt output.

4–13. Image Rejection, IF Rejection and Spurious Signal Rejection Test

a. Connect the RF signal generator to the ANT and GND terminals.

b. Connect the audio power meter to the PHONES jack.

c. Connect the counter through a coaxial "Tee" to the output of the RF signal generator.

d. Set the RF signal generator to 910 kc above the selected frequency and conduct the am. sensitivity test (para 4–11) to determine the image rejection at the image frequency (910 kc above selected frequency).

e. Determine the IF rejection by measuring the am. sensitivity (para 4–11) at the intermediate frequency, 455 kc.

f. Determine the spurious rejection by measuring the am. sensitivity (para 4–11) at the frequencies where spurious responses occur.

4–14. Agc Test

a. Set selector switch S51 to AM, and RF GAIN control R91 to maximum.

b. Connect the RF signal generator to the ANT and GND terminals and connect the audio power meter to the PHONES jack.

c. Set input signal at 1 microvolt modulated 30 percent at 1 kilocycle.

d. Adjust VOL control R69 for audio output at 10 db below 1 milliwatt.

e. Increase the input signal to 100 millivolts and note that this results in less than a 10-db increase in the audio output signal. Appreciable distortion in the audio output should not occur for input signals below 100 millivolt.

4–15. Receiver Blocking, Cw Position Test

a. Set selector switch S51 to CW, and RF GAIN control R91 to maximum.

b. Connect the RF signal generator to the ANT and GND terminals and the audio power meter to the PHONES jack.

c. Set input signal at 0.5 microvolt. Adjust VOL control R69 for an audio output 10 db below 1 milliwatt.

d. Adjust BFO PITCH control C68 for maximum output.

e. Increase input signal level to 1 volt. This should not cause blocking of the receiver (output should not drop to zero).

4–16. RF Gain Control Test

a. Repeat the procedure given in paragraph 4–15*a* through *e*.

b. Set the RF signal generator for a 1-volt signal input.

c. Adjust VOL control R69 for a 1-milliwatt audio output.

d. Turn RF GAIN control R91 to minimum (fully counterclockwise). The audio output should decrease by at least 30 db.

4–17. IF Bandwidth Test

a. Set selector switch S51 to CW.

b. Disable the bfo by short circuiting capacitor C68.

c. Set RF GAIN control R91 to maximum.

d. Set the RF signal generator for 455 kc as read from the frequency meter.

e. Feed an unmodulated signal of approximately 0.5 microvolt to the ANT terminal.

f. Connect an RF voltmeter at TP51.

g. Vary the RF signal generator and record the intermediate frequency at which the IF amplifier output at TP51 is maximum. Record the voltage level at TP51.

h. Adjust the signal generator frequency to both sides of the received center frequency until the level at TP51 drops 6 db below the reference level recorded in *g* above. Record the frequencies where this occurs.

i. Repeat *g* above. Increase the input signal 60 db and adjust the signal generator frequency to both sides of the center frequency until the level at TP51 returns to the value measured in *g* above.

j. Record the frequencies at which this occurs.

4–18. Audio Response Test

a. Set selector switch S51 to AM position. Set VOL control R69 to maximum.

b. Connect the audio power meter and terminate PHONES jack J51 with a 600-ohm resistive load.

c. Connect the RF signal generator to the ANT and GND terminals.

d. Set the input signal at approximately 0.8 microvolt modulated 30 percent at 1 kilocycle.

e. Adjust the frequency for maximum audio output.

f. Set the volume control R69 for approximately 1-milliwatt output.

g. Increase the input signal to 100 microvolts. Set volume control R69 for 1 milliwatt output with modulation at 30 percent at 1 kilocycle.

h. Connect an audio oscillator to the EXT MOD jack on the RF signal generator.

i. Vary the modulating frequency, maintaining 30-percent modulation. Record variation in audio output and frequency in db above or below the 1-kilocycle, 1-milliwatt reference level. The output should be down about 6 db at 2.5 kilocycles.

4–19. IF Amplifier Gain Test

a. Disconnect plug P51 from jack J1 (figs. 4–4 and 4–5).

b. Set AM–CW switch S51 to CW.

c. Advance RF GAIN control R91 maximum clockwise.

d. Measure the dc voltage at TP53; it should read 5.0 volts.

e. Disable the bfo by short circuiting capacitor C68.

f. Feed a 1-millivolt, 455-kilocycle signal to pin D of P51.

Note. The IF amplifier output voltage at TP51 should be approximately 200 to 300 millivolts. Turning the RF GAIN control fully counterclockwise should reduce the IF output 30 db or more.

g. Move selector switch AM–CW S51 to AM.

h. With no signal input into the IF amplifier, adjust AGC SET R64 until the dc voltage at TP53 is 5 volts.

i. Feed the 1-millivolt, 455-kilocycle signal, modulated 30 percent at 1 kilocycle, to pin D of P51. The detected 1-kilocycle signal at TP-52 should be approximately 70 millivolts, and the agc voltage at TP53 should be approximately 9 volts.

4–20. Audio Amplifier Gain Test

a. Disable the bfo by shorting out C68.

b. Connect the audio power meter to the PHONES jack and terminate PHONE jack J51 with a 600-ohm resistive load.

c. Using the RF signal generator, feed a 1-millivolt, 455-killocycle signal, modulated 30 percent at 1 kilocycle, to pin D of P51.

d. Turn the volume control R69, VOL; maximum clockwise and decrease the percentage modulation of the input signal until the output across the 600-ohm load is 1 milliwatt. The audio amplifier input voltage at TP52 should be approximately 10 millivolts.

e. Connect an oscilloscope to the PHONES jack.

f. Observe the waveform of the output as the percentage modulation of the input signal is increased. An audio power output of 4 milliwatts (6 db above 1 milliwatt) should be obtained before appreciable waveform distortion occurs.

g. Remove the short form capacitor C68.

4–21. Beat-Frequency Oscillator Output and Range Test

a. Set selector switch S51 to CW, and set BFO PITCH C68 to the center of its range either by lining up the index in the front panel or by observing the position of the capacitor plates.

b. Connect the frequency meter to TP51.

c. Adjust L51, BFO ADJ (fig. 4–5), until the frequency, as measured at TP51, is approximately 455 kilocycles. The bfo level at TP51 should be about 200 millivolts.

d. Rotate C68 from maximum to minimum capacity and observe the frequency deviation; it should be about 4 kc on either side of 455 kc.

4–22. Front End Alignment

Note. After the preliminary alignment and test of the IF and audio section has been completed (paras 4–11 through 4–21), the IF and audio section is used in aligning the front end of the receiver as in *a* through *h* below.

a. Reconnect plug P51 to jack J1, set selector switch S51 to CW, and turn RF GAIN control R91 to maximum.

b. Disable the bfo by short circuiting capacitor C68.

c. Monitor the IF output at TP51 with an RF voltmeter.

d. Plug a crystal in one of the channel positions, and turn the RCVR CHANNEL selector switch to this position.

Note. On Radio Set AN/TRC–77, if the crystal frequency is below 455 kc, connect the paddling capacitor link across the front end trimmer capacitors corresponding to the proper channel.

e. Feed a cw signal of 455 kc less (or more) than the crystal frequency into the antenna terminals and of sufficient amplitude to give an output of 100 millivolts at TP51. Adjust the frequency control of the signal generator to give a maximum indication.

f. Adjust the appropriate RF tuning capacitor (C3, C5, C7, C9, C11, or C13) and the mixer tuning capacitor (C15, C17, C19, C21, C23, or C25) until a maximum indication is obtained at TP51. As the output at TP51 increases, decrease the input signal so as to maintain the IF output in order of 100 millivolts.

Note. Due to the slight capacitance reversal inherent in the piston trimmers used, the output will not increase smoothly as the capacitor is adjusted, particularly near resonance. Several peaks in the output response may occur. The piston capacitor should be adjusted to that peak which results in the maximum output.

g. When it appears that maximum output has been obtained by the above adjustments, adjust the tuning slug of T1 for maximum output with a nonmetallic tool. It may be necessary to further decrease the input signal level to get a 100-millivolt output.

h. Set the input signal level to 0.5 microvolt and recheck the adjustments of the signal generator frequency, the tuning slug of T1, and the trimmer capacitors.

4–23. First IF Amplifier Neutralization Test

Note. To neutralize the first IF amplifier, break the connection between P51 and J1, contact D. Do this by making up a jumper cord with the D wire from J1 exposed and the D contact of P51 left open (NC).

a. Set selector switch S51 to CW, and turn RF GAIN control R91 to its maximum position.

b. Feed a 455-kilocycle signal to pin D of J1 of sufficient level to give a signal of about 1 millivolt at TP1.

c. Adjust C31 until the signal at TP1 is minimum.

CHAPTER 5

GENERAL SUPPORT TESTING PROCEDURES

5–1. General

a. Testing procedures are prepared for use by Signal field maintenance shops and Signal service organizations responsible for general support maintenance of electronics equipment to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired Radio Set AN/TRC–77(*) *must* meet before it is returned to the using organization. The testing procedures may also be used as a guide for the testing of equipment that has been repaired at direct support, if the proper tools and test equipment are available.

b. Comply with the instructions preceding the body of each chart before proceeding to the chart. Perform each test in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Control settings* columns; then perform each specific test procedure and verify it against its performance standard.

c. All tests will be performed in a well-screened room under the conditions shown below, unless otherwise specified for the individual tests.

Temperature	Room ambient
Humidity	Room ambient
Dummy antenna	50-ohm pad
Channel frequencies:	
Channel 1	3,000 kc
Channel 2	4,060 kc
Channel 3	5,100 kc
Channel 4	6,000 kc
Channel 5	7,000 kc
Channel 6	8,000 kc
Audio output load impedance	600 ohms
Input voltage	12.5 volts dc
RF gain level	Maximum clockwise

5–2. Test Equipment, Tools, Materials, and Additional Equipment Required

a. General. All test equipment, tools, materials and other equipment required to perform the testing procedures given in this section are listed in *b, c, d, e* below and are authorized under TA 11–17 and TA 11–100 (11–17),

b. Test Equipment.

Nomenclature	Federal stock No.	Technical manual
Multimeter ME–26B/U	6625–542–6407	TM 11–6625–200–12
Multimeter TS–352/U	6625–242–5023	TM 11–5527
Oscilloscope AN/USM–140A		TM 11–6625–535–15
Electron Tube Test Set TV–7/U	6625–376–4939	TM 11–6625–274–35
Output Meter TS–585D/U.	6625–244–0501	TM 11–5017
Electronic Voltmeter ME–30B/U	6625–669–0742	TM 11–6625–320–12
Transistor Test Set TS–1836/U		TM 11–6625–539–15
Signal Generator SG–299/U	6625–624–3516	TM 11–5134–15
RF Signal Generator AN/URM–25F	6625–570–5719	TM 11–5551E
Wattmeter AN/URM–120		TM 11–6625–446–15
Electronic Voltmeter AN/URM–145		TM 11–6625–524–14
Frequency Meter AN/USM–26	6625–543–1356	TM 11–5057
Spectrum Analyzer TS–723A/U	3625–668–9418	TM 11–5097

c. Tools. Only Tool Kit TK–100/G is required.

d. Materials. Only Telephone Plug PJ–055–B (or equivalent), FSN 5935–192–4760, is required.

e. Other Equipment. Power supply, variable dc, 10 to 17 volts at 6 amperes.

5–3. Physical Tests and Inspection

a. Test Connections and Conditions. Separate Receiver-Transmitter RT–654/TRC–77(*) from battery case. Remove radio assembly from case.

b. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	*AN/TRC–77(*)* INDICATOR RANGE: OFF Other controls may be in any position.	*a.* Inspect all controls and mechanical assemblies for loose or missing screws, bolts, or nuts. *b.* Inspect all connectors, sockets, and receptacles for looseness and damage.	*a.* Screws, bolts, and nuts will be tight; none missing. *b.* No looseness or damage evident.
2	N/A	Same as 1 above.	*a.* Operate XMTR Channel and RCVR CHANNEL switches to 1, 2, 3, 4, 5, and 6 positions. *b.* Rotate RF GAIN, BFO PITCH and VOL controls throughout their limits of travel. *c.* Operate AM–CW switch to AM and CW. *d.* Operate OFF–RCVR–XMIT switch to OFF, RCVR, and XMIT. *e.* Operate ANT. TUNE switch to 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12. *f.* Operate INDICATOR RANGE switch to OFF 1, 2, and 3.	*a.* Operate freely to each position. *b.* Controls will rotate freely without binding or excessive looseness. *c.* Operates freely to both positions. *d.* Operates freely to all positions. *e.* Operates freely to all positions. *f.* Operates freely to all positions.
3	N/A	Same as 1 above.	Inspect radio case, panel, and chassis for damage, missing parts, and condition of finish and panel lettering. *Note.* Touchup painting is recommended in lieu of refinishing whenever practicable. Screwheads, binding posts, receptacles, and plated fastener parts will not be painted or polished with abrasives.	No damage or missing parts evident. External surfaces intended to be painted will not show bare metal. Panel lettering will be legible.

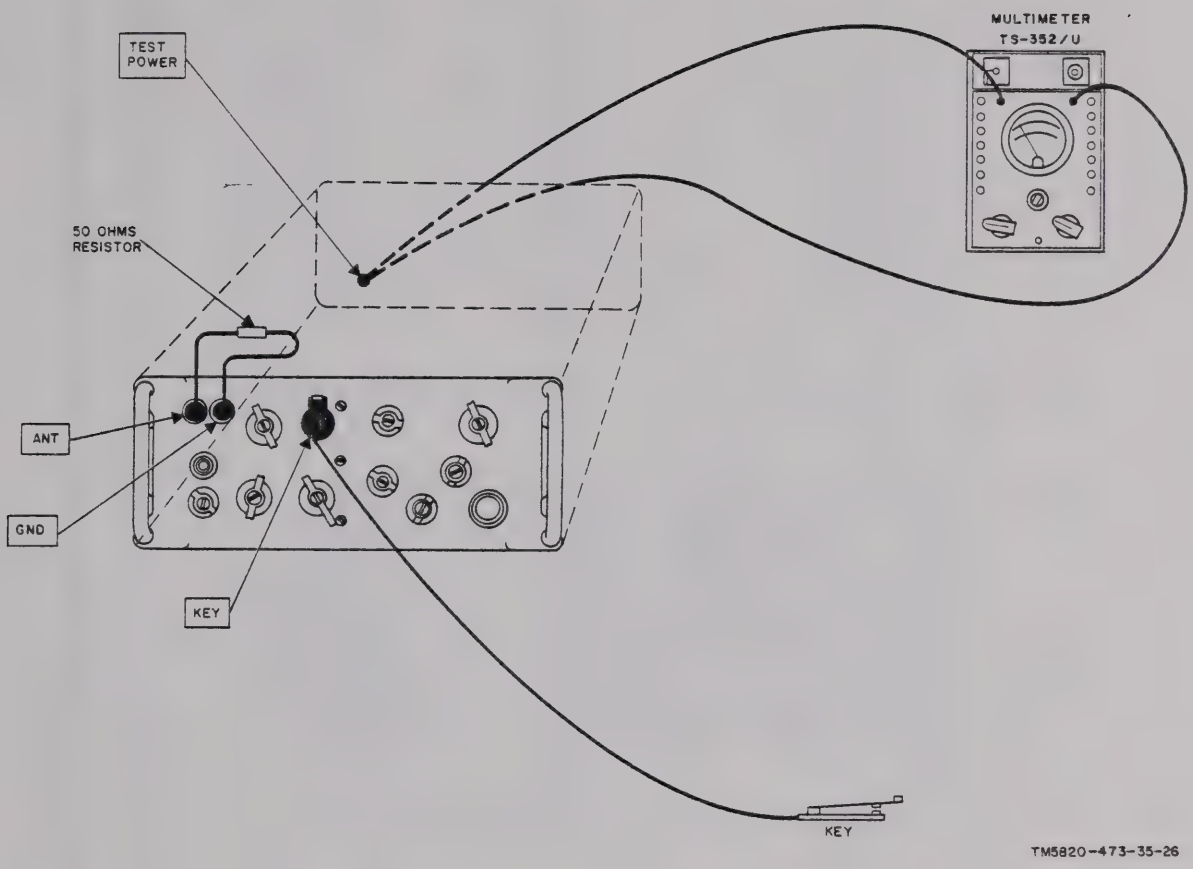


Figure 5-1. Battery current drain test.

5–4. Battery Current Drain Test

a. Test Equipment and Materials. Multimeter TS–352/U. Power supply: able to provide a variable output of from 10 to 17 volts dc at 6 amperes.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–1. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*TS–352/U* FUNCTION: DC CURRENT RANGE: set to maximum and reduce in increments to obtain needle deflection.	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM VOL: MAX RF GAIN: MAX RCVR CHANNEL: any selected channel.	Set power supply voltage at 10-volt input to AN/TRC–77(*) and check current indication on TS–352/U.	TS–352/U indicates 20 ma maximum.
2	Same as 1 above.	Same as 1 above.	Set power supply voltage at 17–volt input to AN/TRC–77(*) and check current indication on TS–352/U.	TS–352/U indicates 20 ma maximum.
3	Same as 1 above.	Same as 1 above, except: *AN/TRC–77(*)* OFF–RCVR–XMIT: XMTR XMTR CHANNEL: any selected channel.	*a.* Close key and adjust ANT. TUNE (S202) on AN/TRC–77(*) for maximum brightness as indicated by the ANT. TUNING INDICATOR. *b.* Check current indication on TS–352/U.	*a.* None. *b.* TS–352/U indicates 3.75 amp maximum.
4	Same as 1 above.	Same as 1 above.	Repeat 3*a* and *b* above for each of five missing channels.	Same as 3*a* and *b* above.

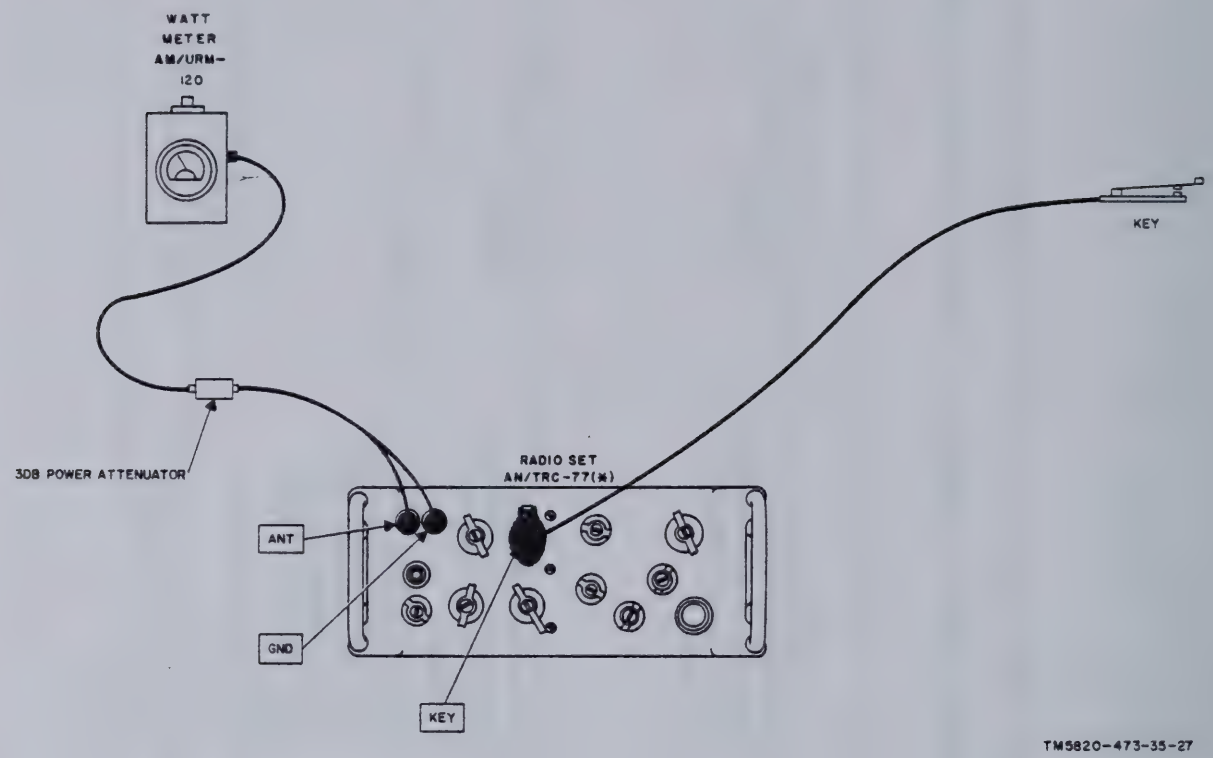


Figure 5-2. Transmitter power output test.

5–5. Transmitter Power Output Test

a. Test Equipment and Materials. Wattmeter AN/URM–120.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–2. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM–120* RANGE SELECTOR SWITCH: 10 watt scale.	*AN/TRC–77(*)* OFF–RCVR–XMIT: XMIT XMTR CHANNEL: 1	*a.* Close key and adjust ANT. TUNE (S202) for maximum output. *b.* Check indication on AN/URM–120.	*a.* None. *b.* AN/URM–120 indicates 5 watts minimum.
2	Same as 1 above.	Same as 1 above.	*a.* Open key and adjust AN/URM–120 to lower scale. *b.* Check indication on AN/URM–120.	*a.* None. *b.* AN/URM–120 indicates 50 db below indication in 1*b* above.
3	Same as 1 above.	Same as 1 above.	Increase input voltage to AN/TRC–77(*) to 17 volts and repeat 1 above.	Same as 1*b* above.
4	Same as 1 above.	Same as 1 above.	*a.* Decrease input voltage to AN/TRC–77(*) to 10 volts. *b.* Close key and adjust ANT. TUNE (S202) for maximum output. *c.* Check indication on AN/URM–120.	*a.* None. *b.* None. *c.* AN/URM–120 indicates 2.5 watts minimum.
5	Same as 1 above.	Same as 1 above.	Repeat 1*a* and *b* above for channels 2, 3, 4, 5, and 6.	Same as 1*b* above.

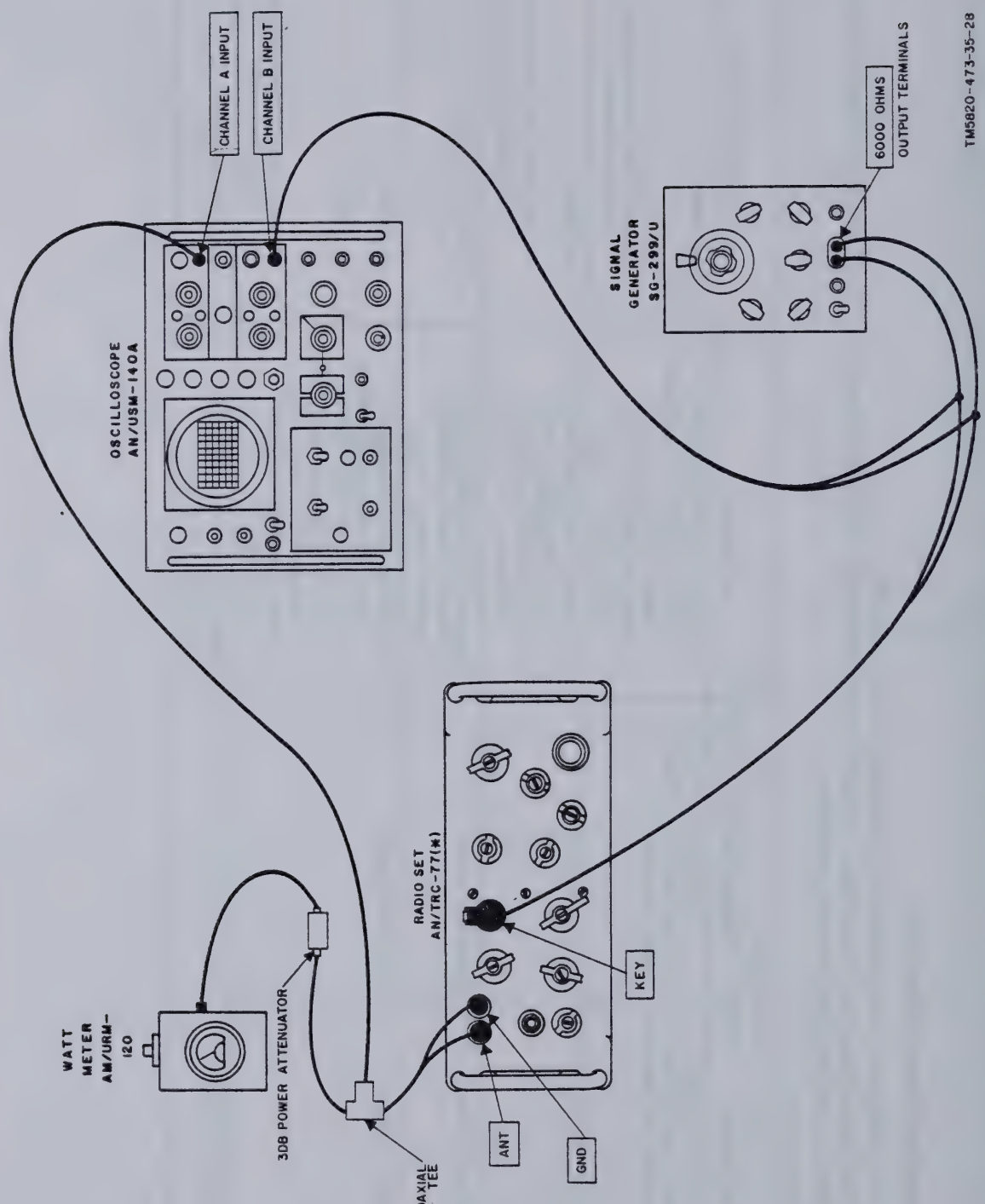


Figure 5-3. Transmitter keyer waveform test.

5–6. Transmitter Keyer Waveform Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.
Wattmeter AN/URM–120.
Oscilloscope AN/USM–140A.
Signal Generator SG–299/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–3. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/URM–120* RANGE SELECTOR SWITCH: 10 watt scale. *AN/USM–140A* CHANNEL SELECTOR: A–B *SG–299/U* RANGE: X100 FREQUENCY: 1.5 75 Ω ATTEN: ODB	*AN/TRC–77(*)* OFF–RCVR–XMIT: XMIT XMTR CHANNEL: 1 ANT. TUNE: adjusted for maximum output.	*a.* Adjust SG–299/U for 150- cps square wave. *b.* Adjust OUTPUT AMPLITUDE control of SG–299/U for 8 volts peak to peak as observed on AN/USM–140A. *c.* Check AN/TRC–77(*) transmitter waveform on AN/USM–140A.	*a.* None. *b.* None. *c.* AN/USM–140A indicates no "degradation" of the output waveform when comparing channel A with channel B.

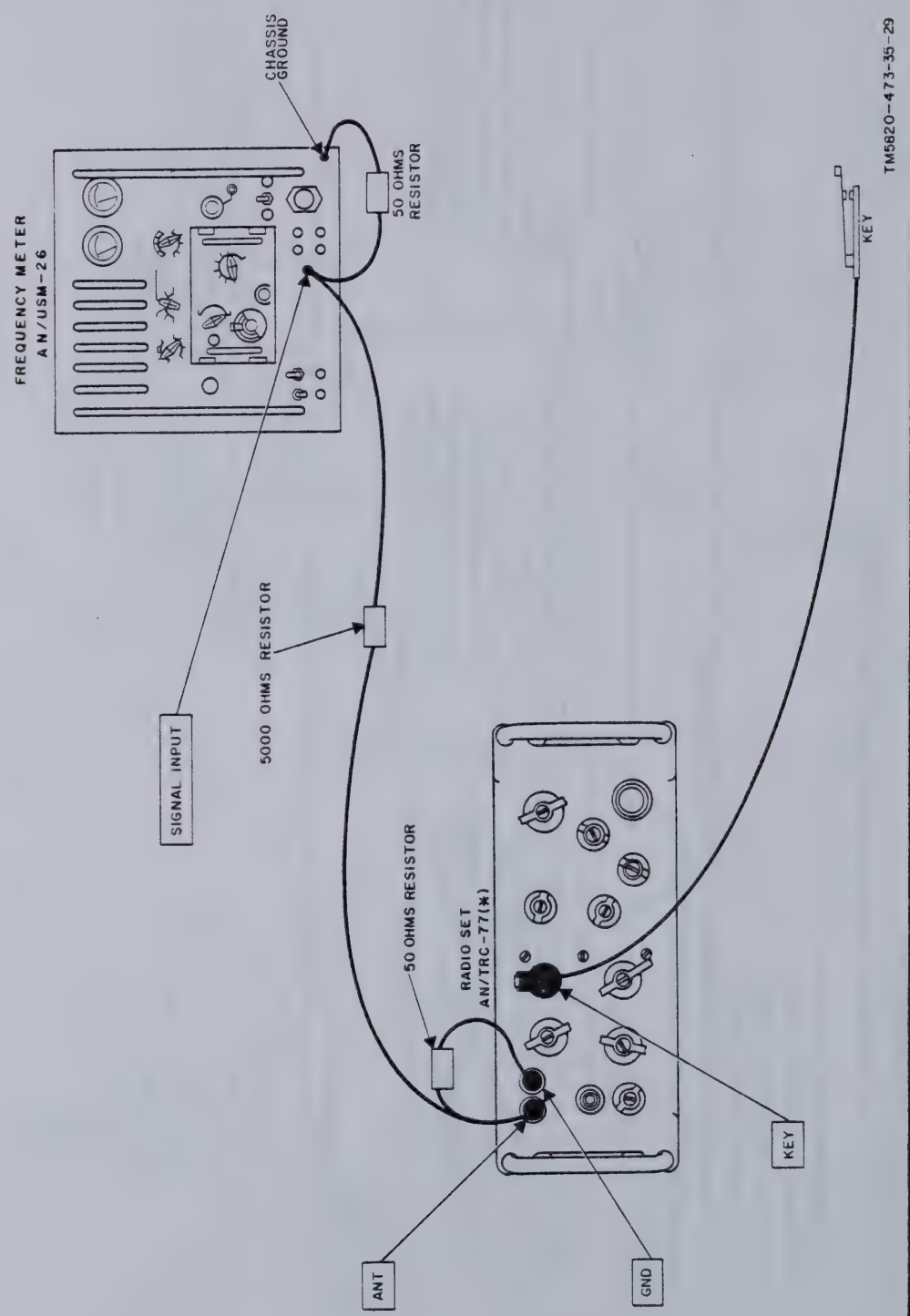


Figure 5-4. Transmitter frequency stability test.

5–7. Transmitter Frequency Stability Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials. Frequency Meter AN/USM–26.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–4. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/USM–26* FUNCTION SELECTOR: FREQUENCY FREQUENCY UNIT: desired gate time (1 or 10 seconds). DISPLAY TIME: CCW MIXING FREQUENCY: 0 GAIN: eye just closes	*AN/TRC–77(*)* OFF–RCVR–XMIT: XMIT XMTR CHANNEL: 1 ANT TUNE: adjusted for maximum power output.	Close key on AN/TRC–77(*) and check the frequency indications on the AN/USM–26 for a period of 5 minutes.	AN/USM–26 indicates 3,000 kc ±240 cps.
2	Same as 1 above.	Same as 1 above, except: XMTR CHANNEL: 2	Same as 1 above.	AN/USM–26 indicates 4,060 kc ±325 cps.
3	Same as 1 above.	Same as 1 above, except: XMTR CHANNEL: 3	Same as 1 above.	AN/USM–26 indicates 5,100 kc ±408 cps.
4	Same as 1 above.	Same as 1 above, except: XMTR CHANNEL: 4	Same as 1 above.	AN/USM–26 indicates 6,000 kc ±480 cps.
5	Same as 1 above.	Same as 1 above, except: XMTR CHANNEL: 5	Same as 1 above.	AN/USM–26 indicates 7,000 kc ±560 cps.
6	Same as 1 above.	Same as 1 above, except: XMTR CHANNEL: 6	Same as 1 above.	AN/USM–26 indicates 8,000 kc ±640 cps.

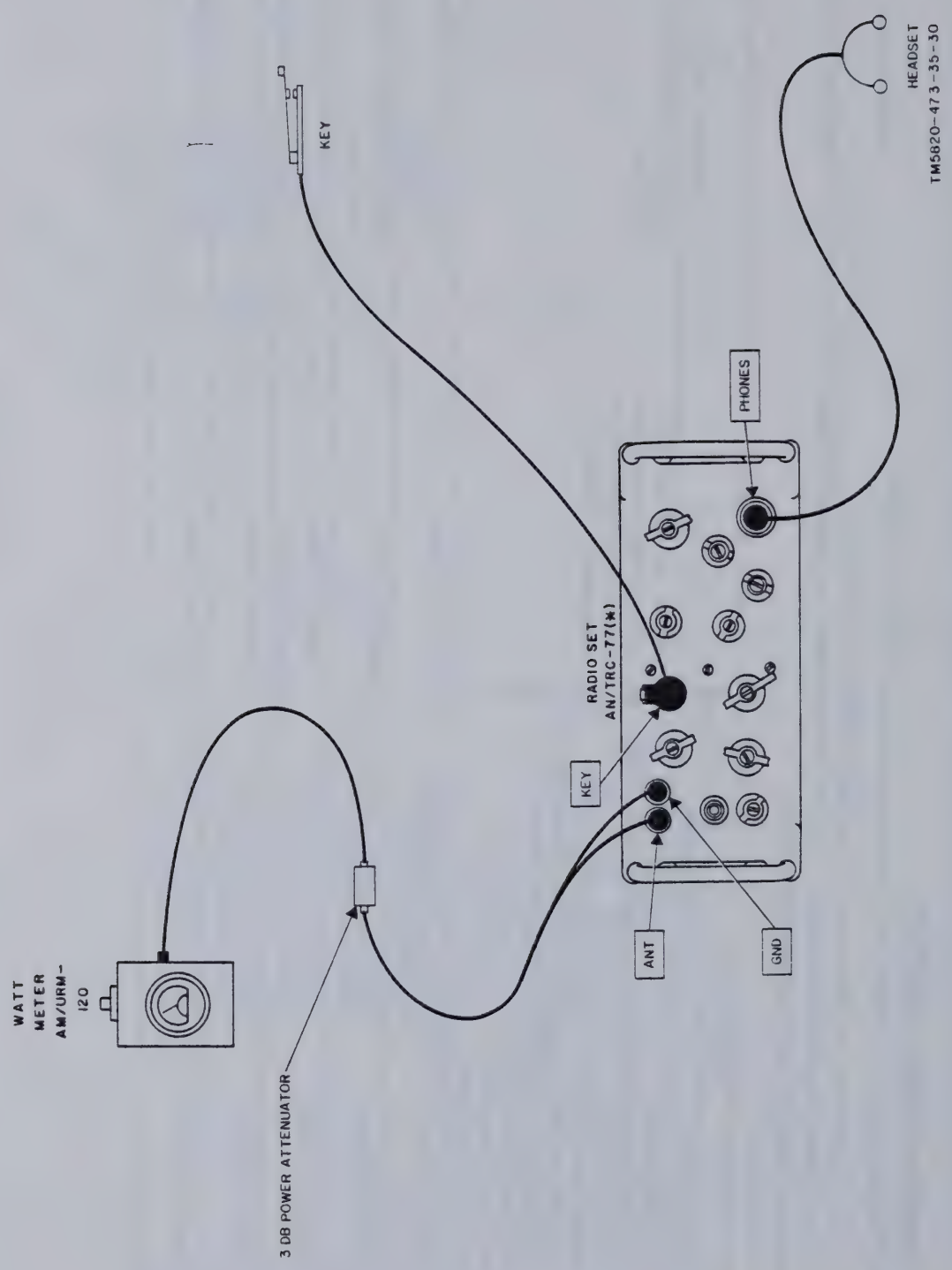


Figure 5-5. Transmitter sidetone oscillator test.

5–8. Transmitter Sidetone Oscillator Test

a. Test Equipment and Materials. Wattmeter AN/URM–120.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–5. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM–120* RANGE switch: 10 watt scale	*AN/TRC–77(*)* OFF–RCVR–XMIT: XMIT XMTR CHANNEL: 1	*a.* Close key on AN/TRC–77(*) *b.* Vary sidetone oscillator control R223 on AN/TRC–77(*) and check the headset for sidetone volume.	*a.* None. *b.* Sidetone volume varies as R223 is varied.

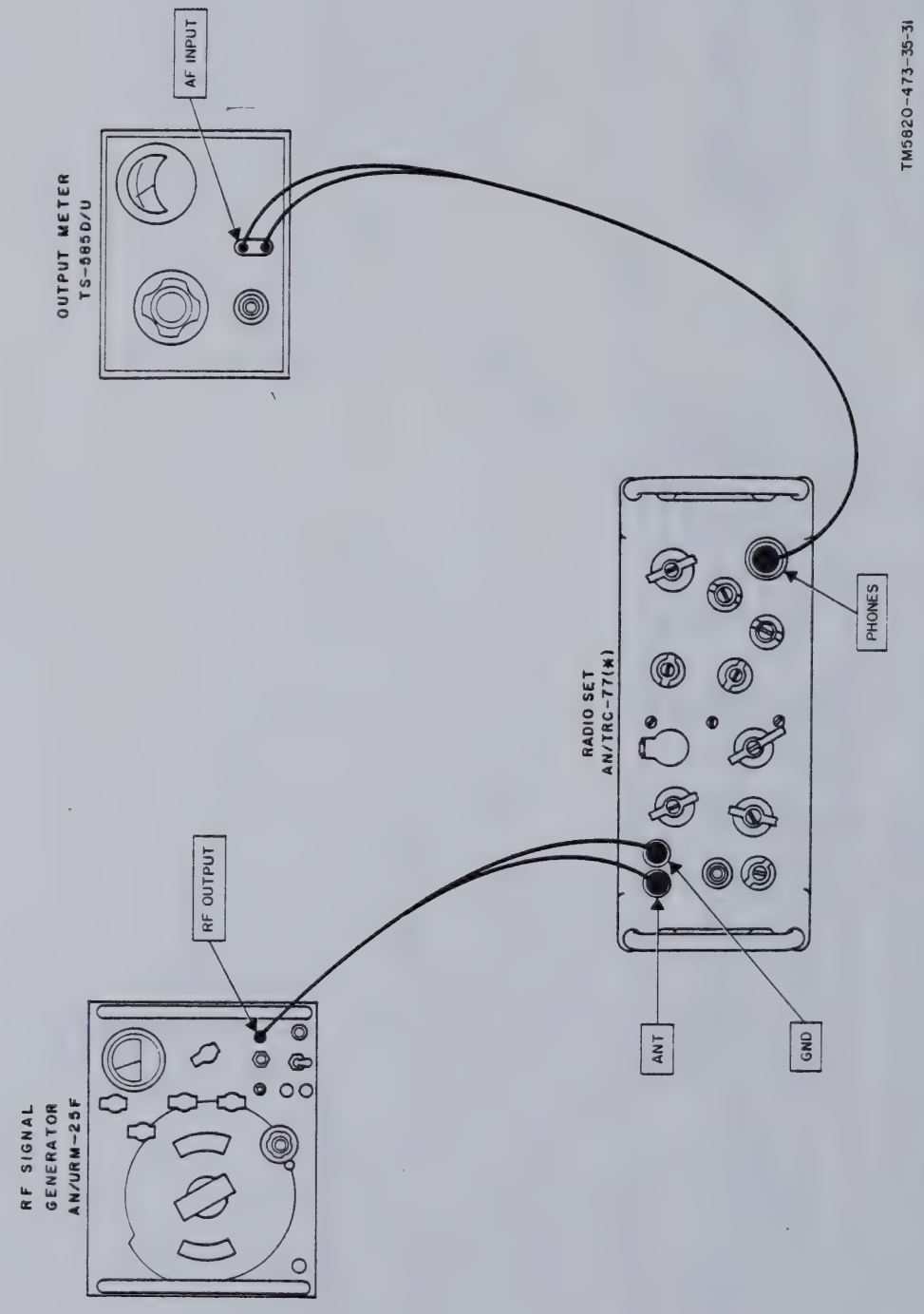


Figure 5-6. Receiver RF gain test.

5–9. Receiver RF Gain Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.

RF signal Generator AN/URM–25F.

Output Meter TS–585D/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–6. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION SWITCH: CW	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: CW	*a.* Disconnect AN/URM–25F from AN/TRC–77(*) and adjust VOL control on AN/TRC–77(*) for 0.1-mw (–10db) noise output on TS–585D/U.	*a.* None.
	TS–585D/U IMPEDANCE CONTROL: adjusted for 600 ohms	RCVR CHANNEL: 1	*b.* Reconnect AN/URM–25F to AN/TRC–77(*) as shown in figure 5–6, and tune AN/URM–25F to CHANNEL 1 of AN/TRC–77(*).	*b.* None..
			c. Adjust output level as observed on TS–585D/U to 1.0 mw (0 db) by adjusting output of AN/URM–25F.	*c.* None.
			d. Repeat *a* through *c* above. Readjust if necessary and record signal level on AN/URM–25F meter. *Note.* Establish the minimum signal level as follows: The minimum signal level is equal to the product of 100,000 x AN/URM–25F meter level. *Example:* .20 microvolts x 100,000 = .02 volt.	*d.* None.
			e. Adujst RF GAIN on AN/TRC–77(*) to minimum gain (fully ccw) position.	*e.* None.
			f. Repeat *b* above and record AN/URM–25F meter level.	*f.* AN/URM–25F indicates that minimum acceptable level is equal to or greater than the product of *d* above.

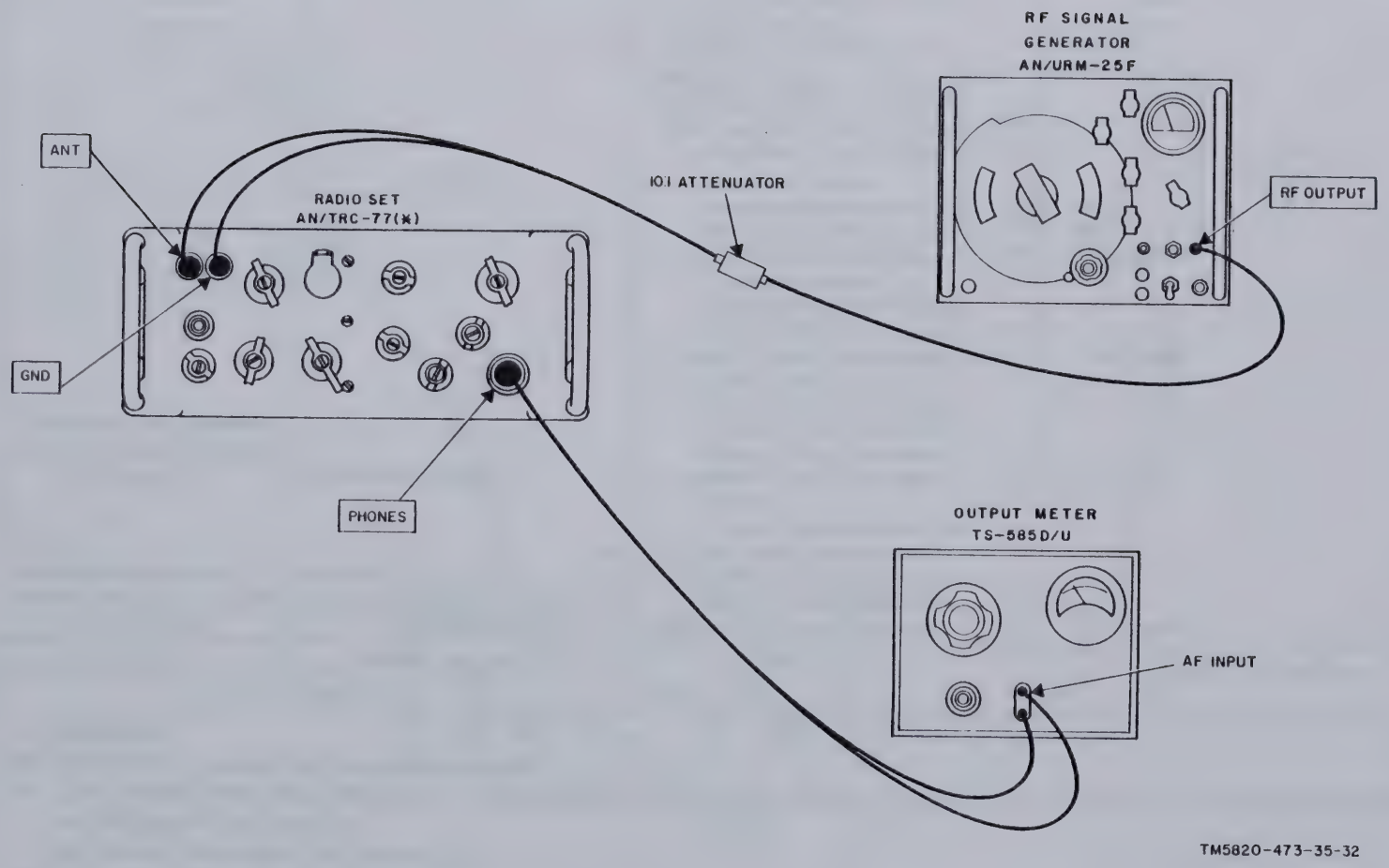


Figure 5-7. Receiver sensitivity test.

5–10. Receiver Sensitivity Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.
RF Signal Generator AN/URM–25F.
Output Meter TS–585D/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–7. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION: % MOD 1,000 *TS–585D/U* IMPEDANCE CONTROL: adjusted for 600 ohms	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM RCVR CHANNEL: selected channel frequency	*a.* Adjust AN/URM–25F for 30% modulation with an output of 10 microvolts at the selected AN/TRC–77(*) channel frequency. *b.* Set FUNCTION switch on AN/URM–25F to CW. Adjust VOL control on AN/TRC–77(*) for 0.1-mw (–10 db) noise output as indicated on TS–585D/U meter. *c.* Set FUNCTION switch on AN/URM–25F to % MOD 1,000 and adjust signal level to obtain 1 mw (0 db) output on TS–585D/U meter. *d.* Repeat *b* and *c* above. Readjust if necessary. *e.* Check AN/URM–25F meter indication. *f.* Repeat *a* through *e* above for the five remaining channels on AN/TRC–77(*).	*a.* None. *b.* None. *c.* None. *d.* None. *e.* AN/URM–25F indicates 22 microvolts maximum. *f.* Same as *e* above.
2	Same as 1 above.	Same as 1 above, except: AM–CW: CW	*a.* Disconnect AN/URM–25F from AN/TRC–77(*) and adjust VOL control on AN/TRC–77(*) for 0.1 mw (–10 db) as indicated by TS–585D/U meter.	*a.* None.

c. Procedures—Continued.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			b. Reconnect AN/URM–25F to AN/TRC–77(*) and tune AN/URM–25F to selected channel frequency. *c.* Set FUNCTION switch on AN/URM–25F to CW. Adjust output level to obtain 1 mw (0 db) as indicated on TS–585D/U. *d.* Repeat *a* through *c* above. Readjust if necessary. *e.* Check signal level indication on AN/URM–25F meter. *f.* Repeat *a* through *e* above for five remaining channels on AN/TRC–77(*).	*b.* None. *c.* None. *d.* None. *e.* AN/URM–25F indicates 10 microvolts maximum. *f.* Same as *e* above.
3	Same as 1 above.	Same as 1 above, except: AM–CW: CW RCVR CHANNEL: 1	*a.* Adjust AN/TRC–77(*) input voltage to 10 volts dc. *b.* Repeat 2*a* through 2*e* above on channel 1 only.	*a.* None. *b.* Same as 2*e* above.
4	Same as 1 above.	Same as 3 above.	*a.* Adjust voltage input to 17 volts dc into AN/TRC–77(*). *b.* Repeat 2*a* through 2*e* above on channel 1 only.	*a.* None. *b.* Same as 2*e* above.

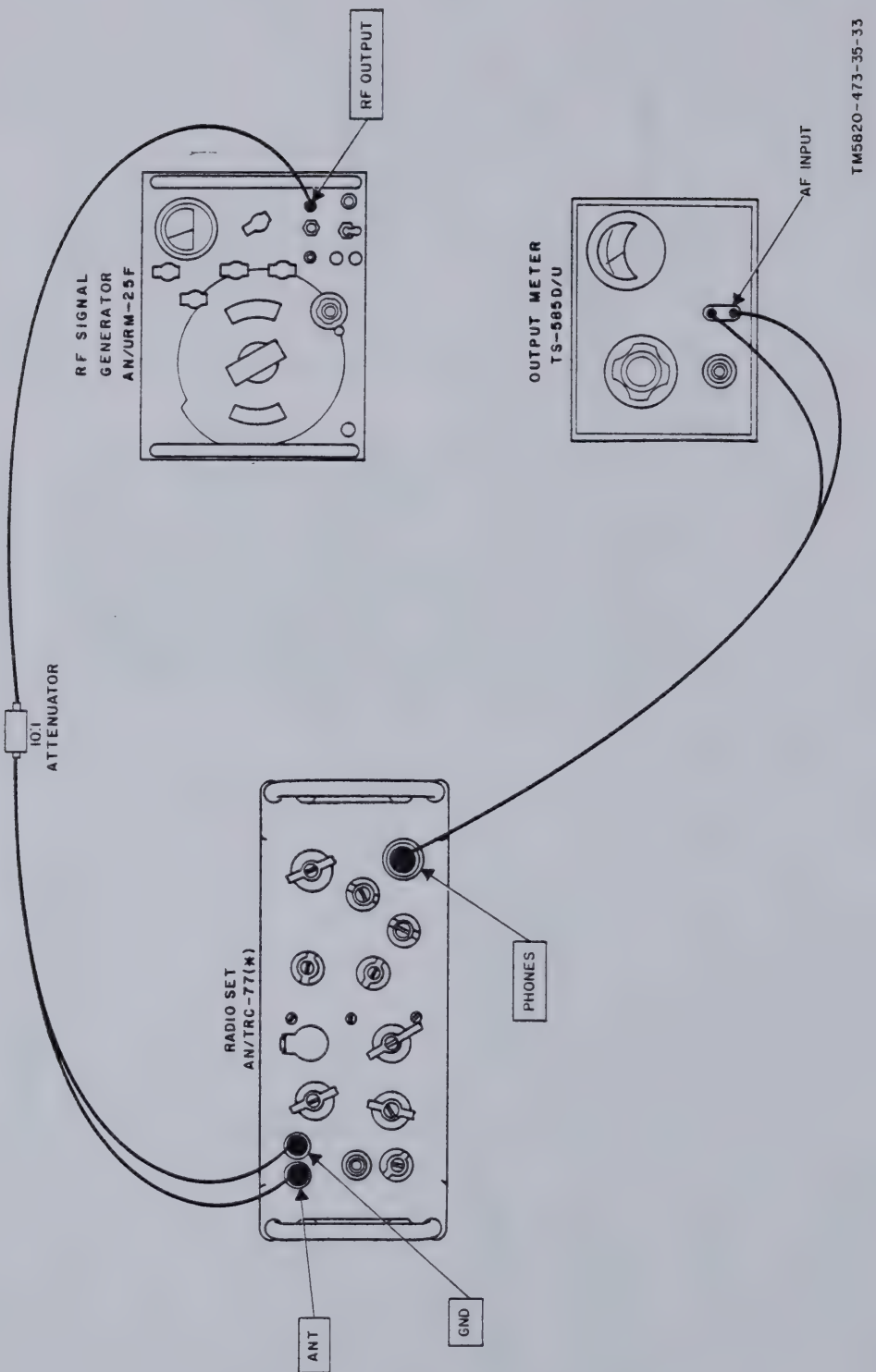


Figure 5-8. Receiver output impedance test.

5–11. Receiver Output Impedance Test

Note: This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.
RF Signal Generator AN/URM–25F.
Output Meter TS–585D/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–8. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION: % MOD 1,000 *TS–585D/U* IMPEDANCE CONTROL: adjusted for 600 ohms	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM RCVR CHANNEL: 1	*a.* Adjust AN/URM–25F output to 1,000 microvolts at 30% modulation and tuned to channel 1 (3,000 kc). *b.* Vary the IMPEDANCE CONTROL of TS–585D/U and record the maximum output indicated on the TS–585D/U meter.	*a.* None. *b.* TS–585D/U indicates maximum indication at 600 ohms matching impedance.

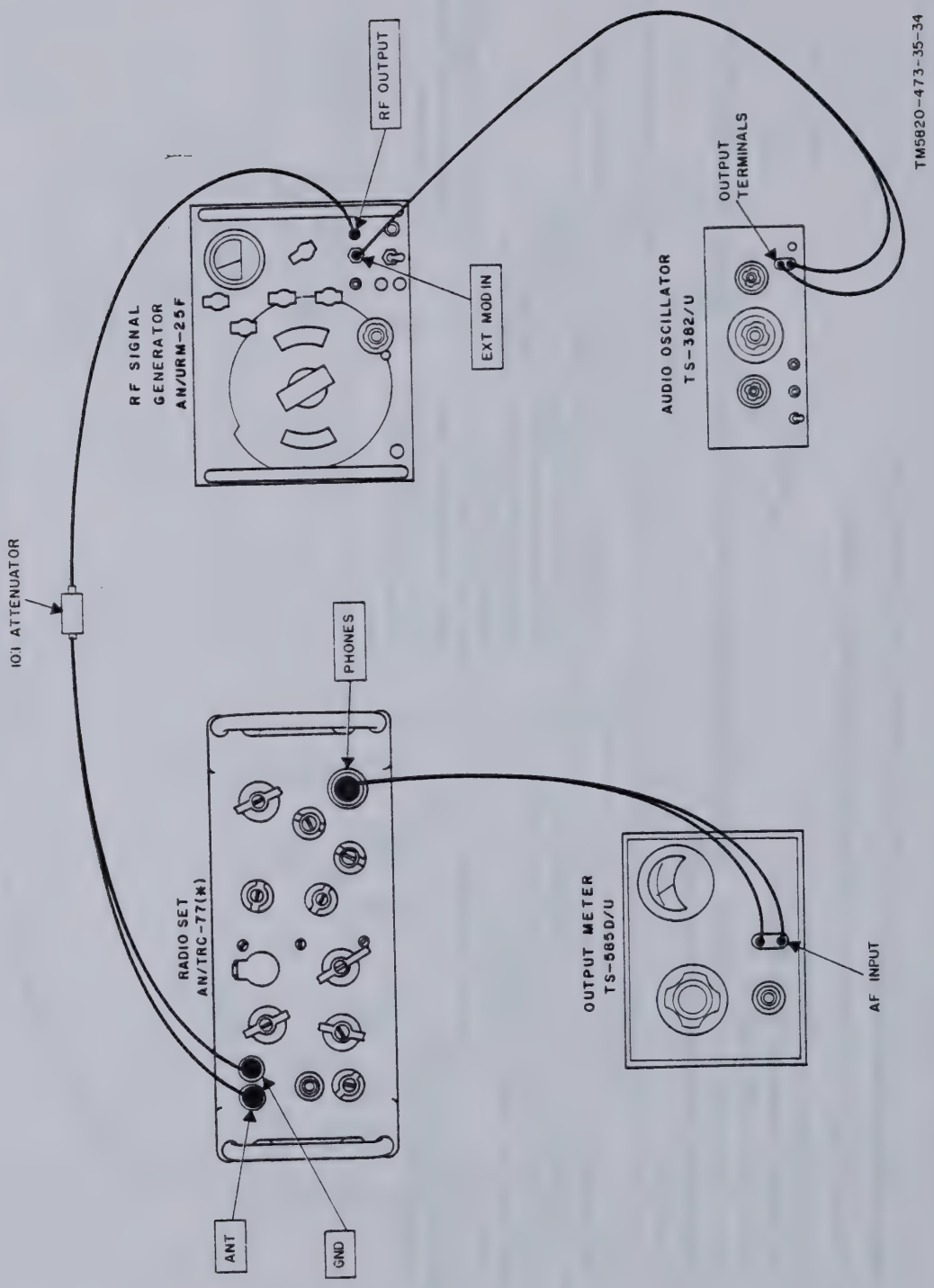


Figure 5-9. Receiver audio response test.

5–12. Receiver Audio Response Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.
Audio Oscillator TS–382/U.
RF Signal Generator AN/URM–25F.
Output Meter TS–585D/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–9. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION: EXT *TS–585D/U* IMPEDANCE CONTROL: adjusted for 600 ohms *TS–382/U* RANGE SWITCH: 1,000	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM RCVR CHANNEL: 1	*a.* Modulate AN/URM–25F 30% at 1,000 cps. *b.* Set AN/URM–25F output to 1,000 microvolts and tune to channel 1 (3,000 kc). *c.* Adjust VOL control on AN/TRC–77(*) until 1-mw (0 db) reference level is indicated on TS–585D/U. *d.* Tune TS–382/U from 300 cps to 2,500 cps and check indication on TS–585D/U.	*a.* None. *b.* None. *c.* None. *d.* TS–585D/U indicates output does not drop below –3 db from 300 cps to 2,000 cps and not below –6 db at 2,500 cps.

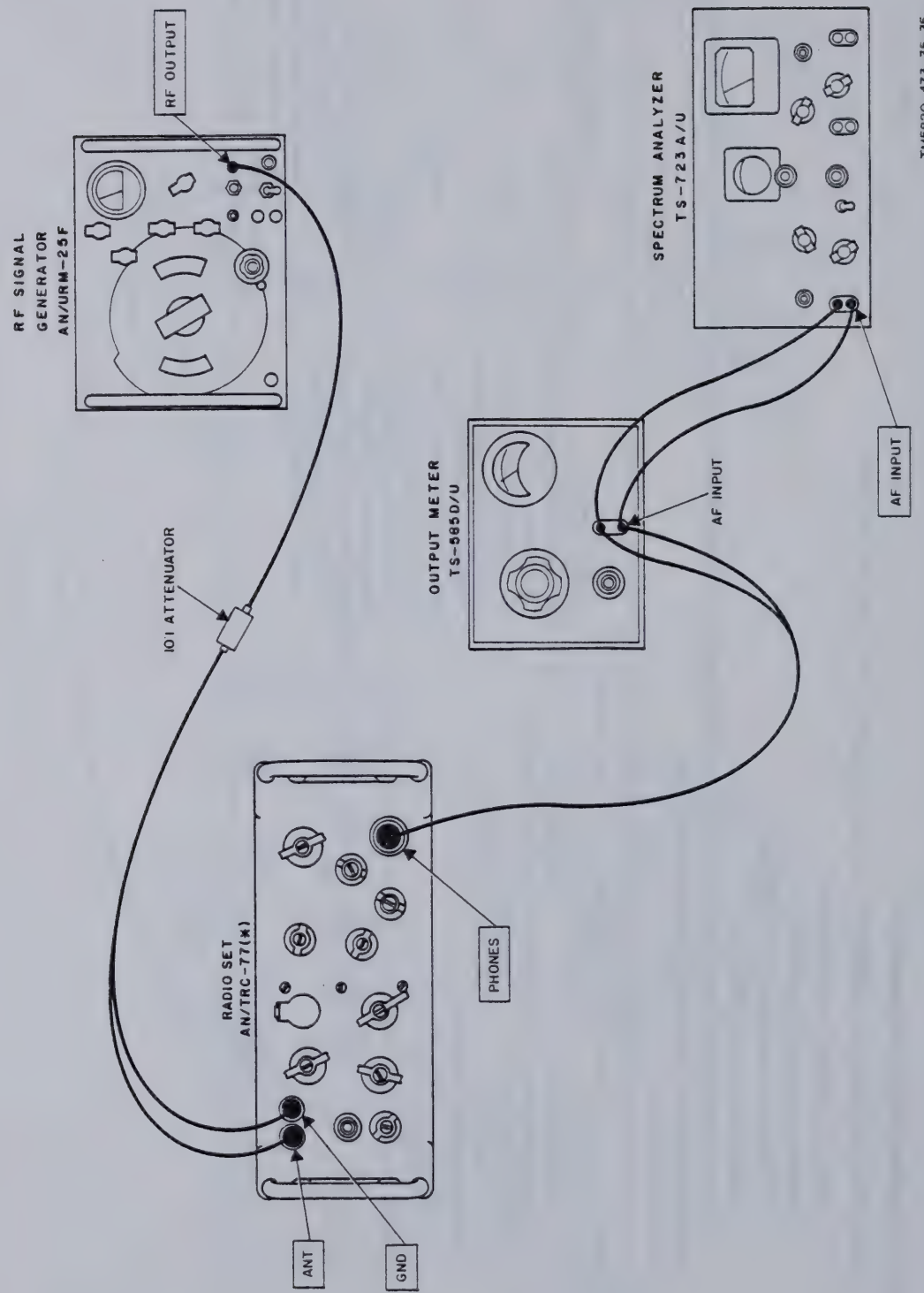


Figure 5-10. Receiver age distortion test.

5–13. Receiver Agc Distortion Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.
RF Signal Generator AN/URM–25F.
Output Meter TS–585D/U.
Spectrum Analyzer TS–723A/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–10. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION: % MOD 1,000 *TS–585D/U* IMPEDANCE CONTROL: adjusted for 600 ohms *TS–723A/U* AF–RF: AF RANGE: X10 FREQUENCY: 1000 FUNCTION SW: Distortion	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM RCVR CHANNEL: 1	*a.* Tune AN/URM–25F to channel 1 (3,000 kc) and adjust for 30% modulation at 1,000 cps with an output of 50 microvolts. *b.* Adjust VOL control on AN/TRC–77(*) to provide a 0.1-mw audio output as indicated on TS–585D/U. *c.* Check percent of distortion on TS–725A/U.	*a.* None. *b.* None. *c.* TS–723A/U indicates 15% maximum.
2	Same as 1 above.	Same as 1 above.	Repeat 1*a* through *c* above for each of the following AN/URM–25F signal levels: (1) 160 microvolts (2) 500 microvolts. (3) 1,600 microvolts. (4) .005 volt. (5) .016 volt. (6) .05 volt. *Note:* Do not readjust VOL control on AN/TRC–77(*) at each signal level above.	Same as 1*c* above.

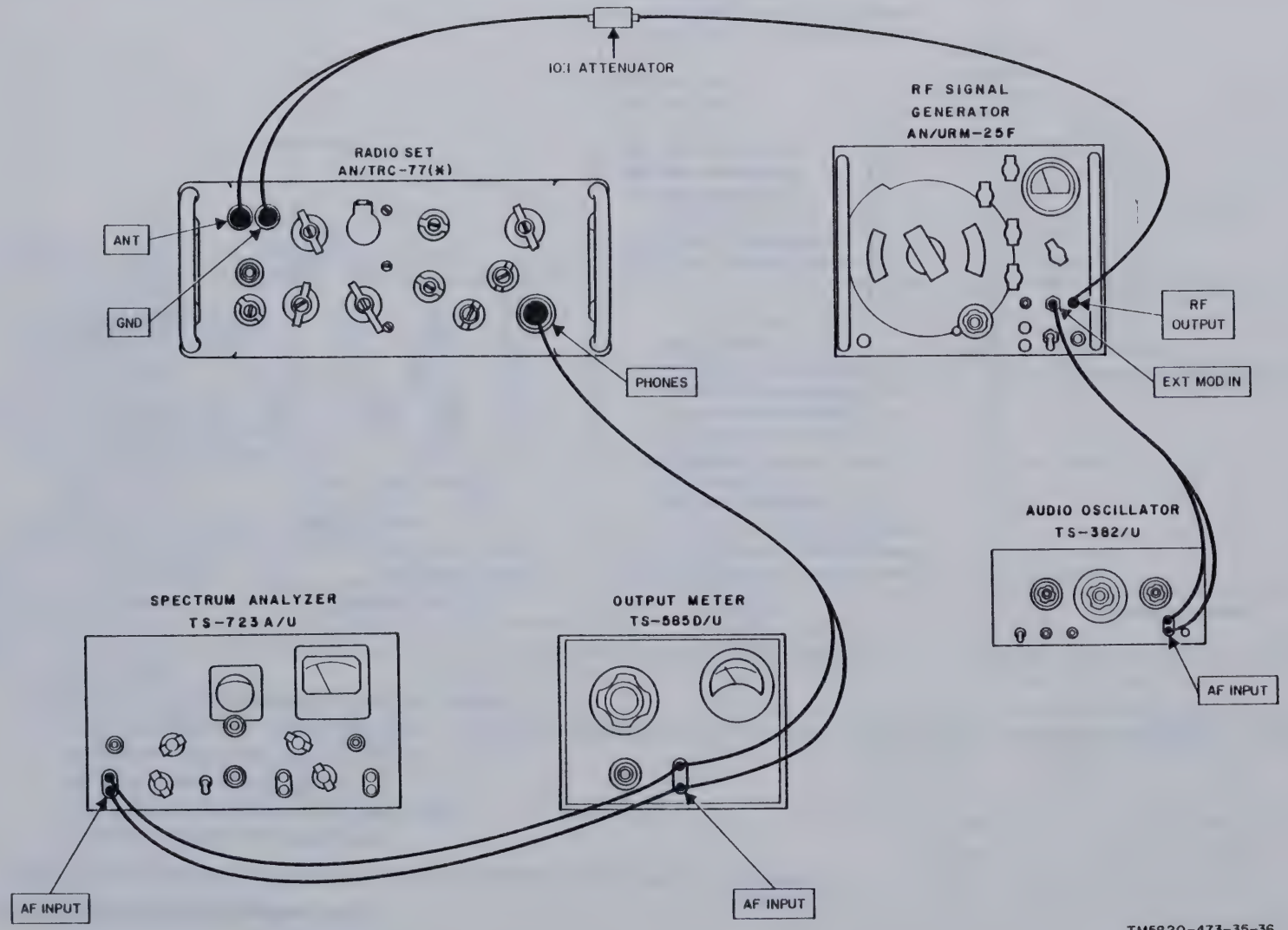


Figure 5-11. Receiver audio distortion test.

5–14. Receiver Audio Distortion Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials.
RF Signal Generator AN/URM–25F.
Audio Oscillator TS–382/U.
Output Meter TS–585D/U.
Spectrum Analyzer TS–723A/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–11. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION: EXT *TS–585D/U* IMPEDANCE CONTROL: adjusted for 600 ohms *TS–382/U* RANGE SWITCH: 1,000 *TS–723A/U* AF–RF: AF RANGE: X10 FREQUENCY: 1,000 FUNCTION SW: DISTORTION	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM RCVR CHANNEL: 1	*a.* Using TS–382/U, modulate AN/URM–25F 30% at 1,000 cps. Set AN/URM–25F output for 1,000 microvolts and tune to channel 1 (3,000 kc) of AN/TRC–77(*). *b.* Adjust VOL control of AN/TRC–77(*) for 1-mw indication on TS–595D/U. *c.* Check percent of distortion on TS–723A/U.	*a.* None. *b.* None. *c.* TS–723A/U indicates 10% maximum.
2	Same as 1 above, except: *TS–382/U* RANGE SWITCH: set to tune for 300 cps	Same as 1 above.	Repeat 1*a* through *c* above except modulate 30% at 300 cps in 1*a* above.	Same as *c* above.
3	Same as 1 above, except: *TS–382/U* RANGE SWITCH: set to tune for 2,500 cps	Same as 1 above.	Repeat 1*a* through *c* above except modulate 30% at 2,500 cps in 1*a* above.	Same as *c* above.

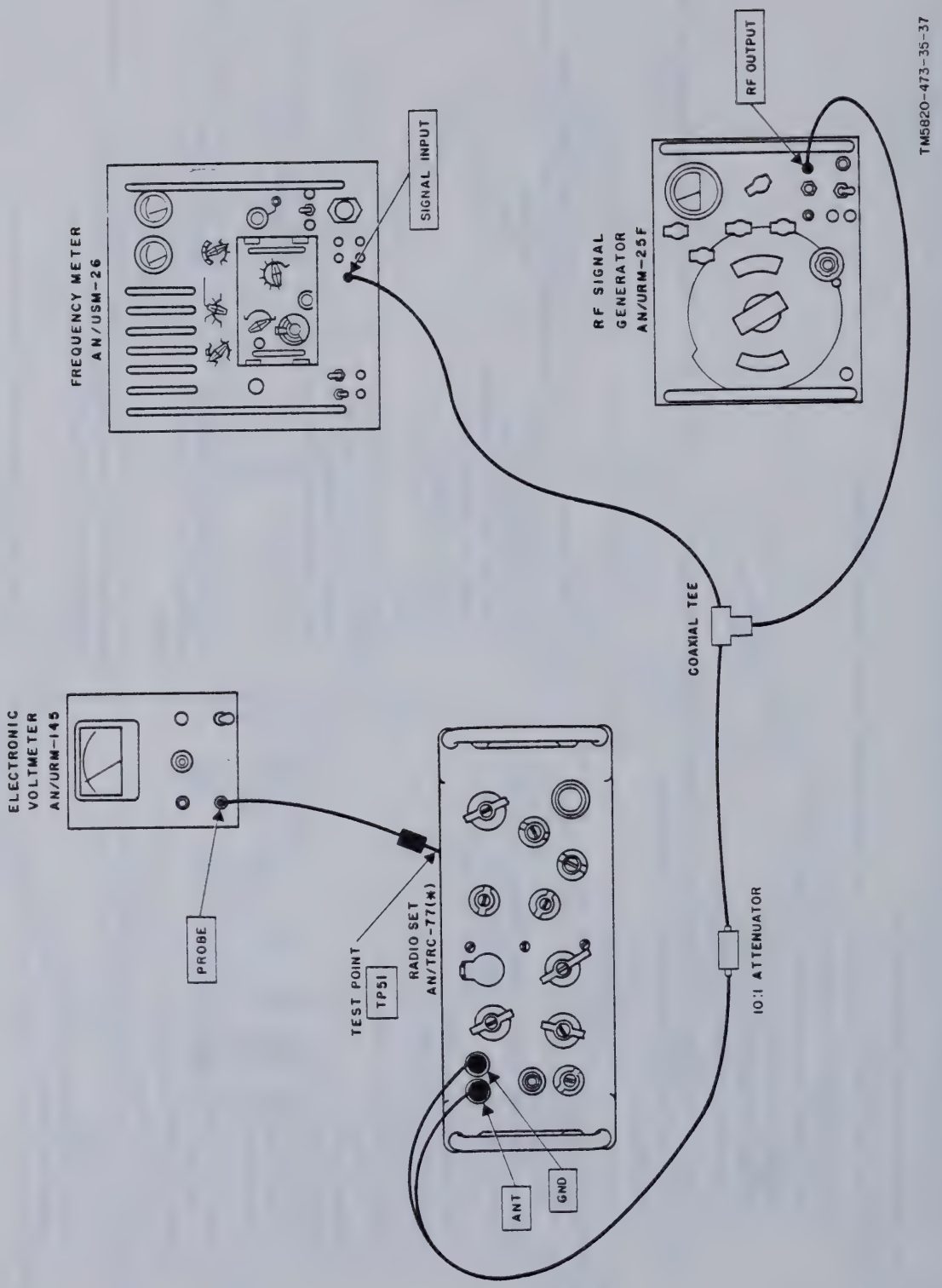


Figure 5-12. Receiver IF bandwidth test.

5–15. Receiver IF Bandwidth Test

Note. This test should be conducted in an electromagnetic screen room or equavilent.

a. Test Equipment and Materials.

RF Signal Generator AN/URM–25F.
Frequency Meter AN/USM–26.
Electronic Voltmeter AN/URM–145.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–12. Disable bfo by shorting C68 to ground. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/URM–25F* BAND SWITCH: 1.5–3.8 FUNCTION: CW *AN/URM–145* RANGE-FULL SCALE: set to highest scale, then reduce to midscale reading. *AN/USM–26* FUNCTION SELECTOR: FREQUENCY FREQUENCY UNIT: desired gate time (1 or 10 seconds) DISPLAY TIME: CCW MIXING FREQUENCY: 0 GAIN: eye just closes RANGE–MC:	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: CW RCVR CHANNEL: any selected channel.	*a.* Adjust AN/URM–25F to selected channel frequency at a level of 50 microvolts. Check indication on AN/URM–145. *b.* Increase AN/URM–25 F input 6 db and operate AN/URM–25F TUNING control clockwise (recording AN/USM–26 indication) and then counterclockwise (recording ON/USM–26 indication) until AN/URM–145 indicates same as in *a* above.	*a.* None. *b.* AN/USM–26 indicates difference in frequency between two points is: 5 kc minimum and 6 kc maximum.
2	Same as 1 above.	Same as 1 above.	*a.* Repeat 1*a* above. *b.* Increase AN/URM–25F input 60 db and operate AN/URM–25F TUNING control clockwise (recording AN/USM–26 indication) and then counterclockwise (recording AN/USM–26 indication) until AN/URM–145 indicates same as in 1*a* above.	*a.* None. *b.* AN/USM–26 indication: difference in frequency between the two points should be 16 kc maximum.
3	Same as 1 above.	Same as 1 above.	Repeat 1*a*, 1*b*, 2*a*, and 2*b* above for each of the five remaining channels on AN/TRC–77(*).	Same as 1*b* and 2*b* above.

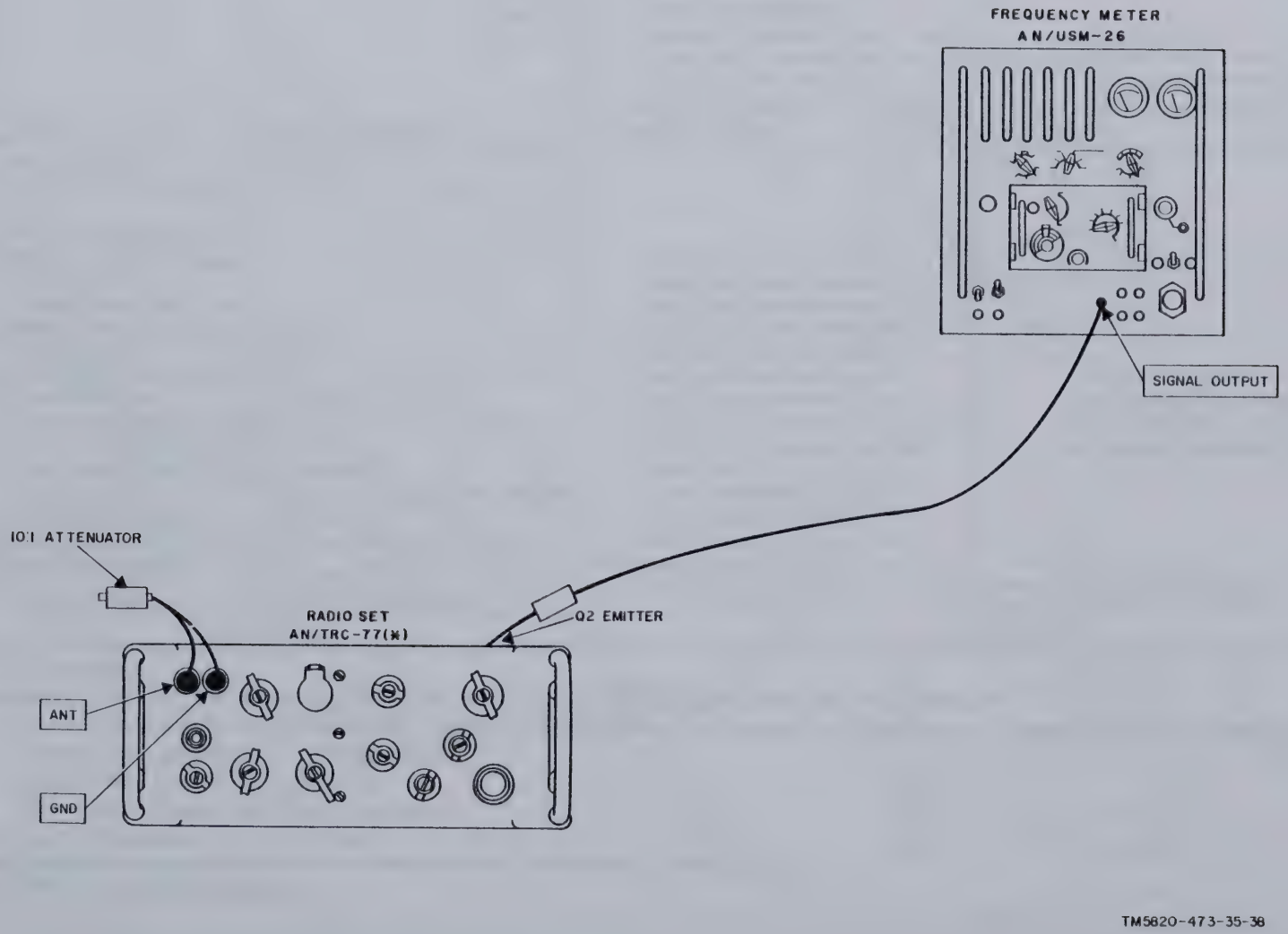


Figure 5-13. Receiver frequency stability test.

5–16. Receiver Frequency Stability Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials. Frequency Meter AN/USM–26.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–13. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/USM–26* FUNCTION SELECTOR: FREQUENCY FREQUENCY UNIT: desired gate time (1 or 10 seconds) DISPLAY TIME: CCW MIXING FREQUENCY: 0 GAIN: eye just closes. RANGE: MC	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: AM RCVR CHANNEL: any selected channel	Check the frequency indications on AN/USM–26 for a period of 5 minutes on each channel. Check all six channels.	AN/USM–26 indicates as follows: Channel 1: 3,455 kc ±240 cps. Channel 2: 4,515 kc ±325 cps. Channel 3: 5,555 kc ±408 cps. Channel 4: 6,455 kc ±480 cps. Channel 5: 7,455 kc ±560 cps. Channel 6: 8,455 kc ±640 cps.

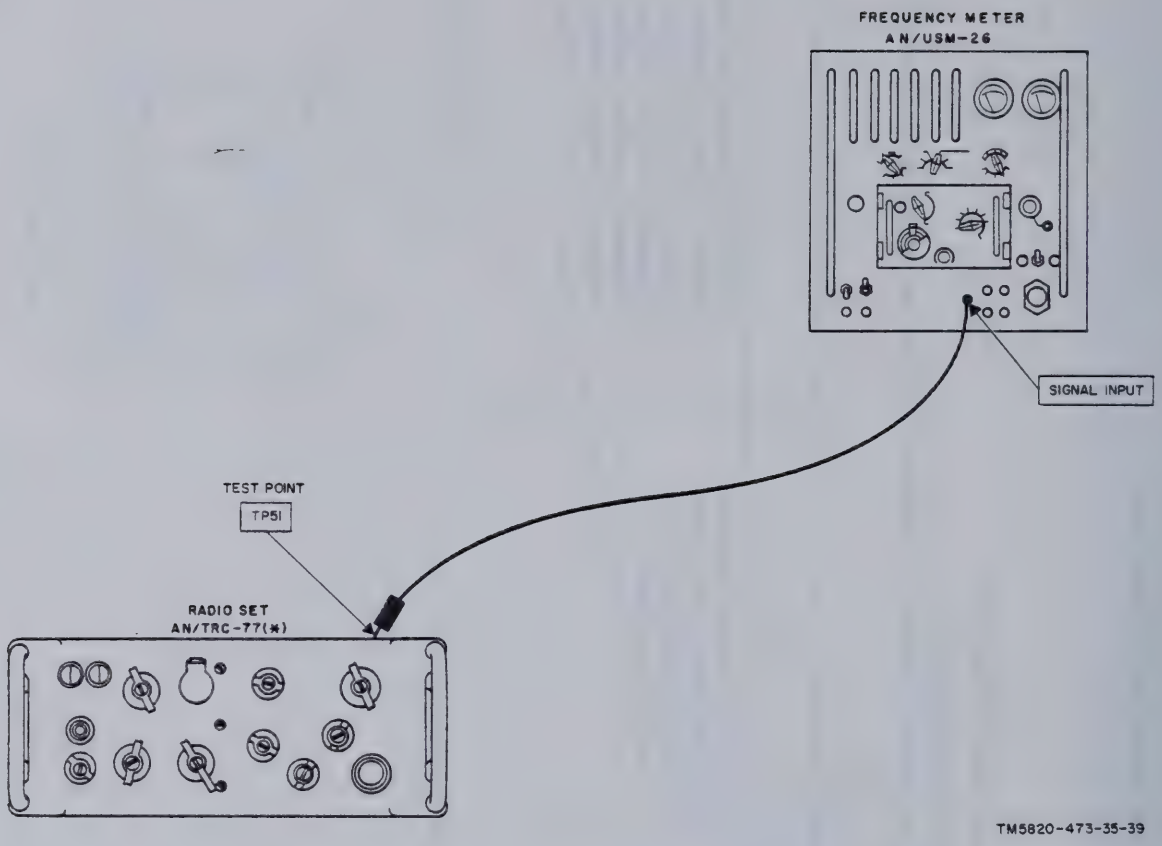


Figure 5-14. Receiver bfo oscillator test.

5–17. Receiver Bfo Test

Note. This test should be conducted in an electromagnetic screen room or equivalent.

a. Test Equipment and Materials. Frequency Meter AN/USM–26.

b. Test Connections and Conditions. Connect the equipment as shown in figure 5–14. Turn on the equipment and allow it to warm up for 20 minutes before proceeding.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	*AN/USM–26* FUNCTION SELECTOR: FREQUENCY FREQUENCY UNIT: desired gate time (1 or 10 seconds) DISPLAY TIME: CCW MIXING FREQUENCY: 0 GAIN: eye just closes RANGE: MC	*AN/TRC–77(*)* OFF–RCVR–XMIT: RCVR AM–CW: CW	*a.* Set BFO PITCH on AN/TRC–77(*) to the center of its range either by lining up the index (0) on the front panel of AN/TRC–77(*) or by observing the position of capacitor plates. Check the frequency indication on AN/USM–26.	*a.* None.
			b. Rotate BFO PITCH on AN/TRC–77(*) to maximum and record frequency indication from AN/USM–26.	*b.* None.
			c. Rotate BFO PITCH to minimum and record reading from AN/USM–26.	*c.* None.
			d. Check the difference in frequency between *a* and *b* above.	*d.* Difference of 2,500 cps minimum.
			e. Record the difference in frequency between *a* and *c* above.	*e.* Difference of 2,500 cps minimum.
2	Same as above.	Same as above.	*a.* Adjust BFO PITCH on AN/TRC–77(*) for frequency reading of 455 kc on AN/USM–26.	*a.* None.
			b. Record indication from AN/USM–26 after 5 minutes.	*b.* AN/USM–26 indicates 455 kc ±227 cps.

CHAPTER 6

DEPOT OVERHAUL STANDARDS, RADIO SET AN/TRC 77(*)

6–1. Applicability of Depot Overhaul Standards

The tests outlined in this section are designed to measure the preformance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

6–2. Applicable References

a. Repair Standards. Applicable procedures of the depots performing these tests and the general standards for repaired electronic equipment given in TB SIG 355–1, TB SIG 355–2, and TB SIG 355–3 form a part of the requirements for testing this equipment.

b. Technical Publications. The following technical publications are applicable to this equipment:

Title	Number
Organizational Maintenance Manual, Radio Set AN/TRC–77(*) DS, GS, and Depot Maintenance Manual, Radio Set AN/TRC–77(*)	TM 11–5820–473–12 TM 11–5820–473–35

c. Modification Work Orders. Perform all applicable modification work orders pertaining to this equipment before making the tests specified. DA PM 310–4 lists all available MWO's.

6–3. Test Facilities Required

The following equipment, or suitable equivalents, will be employed in determining compliance with the requirements of this Specific Standard.

a. Test Equipment.

Equipment	Stock No.	Qty reqd	Applicable manual
Multimeter ME–26B/U	----	1	TM 11–6625–200–12
Multimeter TS–352/U	----	1	TM 11–5527
Oscilloscope AN/USM–140A	----	1	TM 11–6625–535–15
Electron Tube Test Set TV–7U	----	1	TM 11–6625–274–35
Output Meter TS–585D/U	----	1	TM 11–5017
Electronic Voltmeter. ME–30B/U	----	1	TM 11–6625–320–12
Transister Test Set TS–1836/U	----	1	TM 11–6625–539–15
Signal Generator SG–299/U	----	1	TM 11–5134–15
RF Signal Generator AN/URM–25F	----	1	TM 11–5551E
Wattmeter AN/URM–120	----	1	TM 11–6625–446–15
Electronic Voltmeter AN/URM–145	----	1	TM 11–6625–524–14
Frequency Meter AN/USM–26	----	1	TM 11–5057
Signal Generator AN/USM–44	----	1	
Spectrum Analyzer TS–723A/U	----	1	TM 11–5097
Audio Oscillator TS–382/U	----	1	TM 11–6625–261–12

b. Additional Equipment.

Equipment	Stock No.	Qty reqd
Power supply: capable of delivering a variable voltage of from 10 to 17 volts dc at 6 amperes.	----	1

6-4. General Test Requirements

Most of the tests will be performed in a well-screened room under the following conditions, unless otherwise specified for the individual tests:

a. Temperature ..... Room ambient.
b. Humidity ..... Room ambient.
c. Dummy antenna ..... 50-ohm pad.
d. Channel frequencies:
  (1) Channel 1 ..... 3,000 kc.
  (2) Channel 2 ..... 4,060 kc.
  (3) Channel 3 ..... 5,100 kc.
  (4) Channel 4 ..... 6,000 kc.
  (5) Channel 5 ..... 7,000 kc.
  (6) Channel 6 ..... 8,000 kc.
e. Audio output load impedance ..... 600 ohms.
f. Input voltage ..... 12.5 volts dc.
g. RF gain level ..... Maximum clockwise.

6-5. Tests on Radio Set AN/TRC-77(*)

a. Receiver Battery Current Drain Check. Connect the equipment as shown in figure 6-1, and make the receiver battery current drain check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
  (*a*) AM-CW at AM.
  (*b*) OFF-RCVR-XMIT at RCVR.
  (*c*) RCVR CHANNEL at any selected channel.
  (*d*) RF GAIN at maximum.
  (*e*) VOL at maximum.
(2) Set the power supply voltage at 10 volts input, and note the current reading on Multimeter TS-352/U (current meter).
(3) Set the power supply voltage at 17 volts input, and note the current reading on the current meter.
(4) Readings obtained in (2) and (3) above will be a maximum of 20 milliamperes.

b. Transmitter Battery Current Drain Check. Connect the equipment as shown in figure 6-1, and make the transmitter battery current drain check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as follows:
  (*a*) OFF-RCVR-XMIT at XMIT.
  (*b*) XMIT CHANNEL at any selected channel (all six channels will be checked).
(2) Close the key.
(3) Adjust ANT TUNE switch S202 for maximum brightness as indicated by the ANT. TUNE INDICATOR. The output indicator switch, INDICATOR RANGE, allows the indicator lamp brilliance to be adjusted to its most useful range.
(4) Note the current meter reading.
(5) The reading noted in (4) above will not exceed 3.75 amperes.
(6) Repeat the procedures given in (1) through (6) for the remaining five channels.

6-6. Tests on Transmitter, Radio Set AN/TRC-77(*)

a. Power Output Check. Connect the equipment as shown in figure 6-2, and make the power output check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
  (*a*) OFF-RCVR-XMIT at XMIT.
  (*b*) XMTR CHANNEL at any channel (all six channels will be checked).
(2) Adjust the power meter to the 10-watt scale.
(3) Close the key and adjust the ANT. TUNE switch for maximum output on the power meter.
(4) The output on the power meter will be 5 watts minimum.
(5) Note the output on channel 1.
(6) Open the key and adjust the power meter to the lower scales.
(7) The open key output of the transmitter will be at least 40 db below reading noted in (5) above.
(8) Increase the dc input to 17 volts, and repeat the procedures in (1) through (4) above on channel 1 only.
(9) Decrease the dc input to 10 volts, and repeat the procedures in (1) through (3) above on channel 1 only. The output on the power meter will be 2.5 watts minimum.

(10) Repeat the procedures given in (1) through (4) above for the five remaining channels.

b. Keyer Waveform Check. Connect the equipment as shown in figure 6–3, and make the keyer waveform check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) OFF–RCVR–XMIT at XMIT.
  (*b*) XMTR CHANNEL at channel 1.
  (*c*) ANT TUNE adjusted for maximum output.
(2) Adjust the square wave generator frequency to 150 cps. Using the oscilloscope, set the output level to 8 volts peak-to-peak.
(3) Observe the transmitter output waveform on the oscilloscope.
(4) There will be no degradation of the output waveform observed in (3) above.

c. Frequency Stability Check. Connect the equipment as shown in figure 6–4, amd make the frequency stability check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) OFF–RCVR–XMIT at XMIT.
  (*b*) ANT TUNE adjusted for maximum output.
  (*c*) XMTR CHANNEL at any selected channel (all six channels will be checked).
(2) Close the key, and record the frequency readings from the counter for a period of 5 minutes.
(3) The difference between the highest and lowest frequencies recorded in (2) above will be equal to or less than .008 percent of the nominal channel frequency.

Channel	Nominal frequency	Maximum change allowed
1	3,000 kc	240 cps
2	4,060 kc	325 cps
3	5,100 kc	408 cps
4	6,000 kc	480 cps
5	7,000 kc	560 cps
6	8,000 kc	640 cps

(4) Repeat the procedures in (2) and (3) above for the remaining five channels.

d. Sidetone Oscillator Check. Connect the equipment as shown in figure 6–5, and make the sidetone oscillator check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) OFF–RCVR–XMIT at XMIT.
  (*b*) XMTR CHANNEL at channel 1.
(2) Close the key.
(3) The sidetone oscillator control, R223, will vary the volume of the tone heard in the headset.

6–7. Tests on Receiver, Radio Set AN/TRC–77(*)

a. RF Gain Check. Connect the equipment as shown in figure 6–6, and make the RF gain check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) AM–CW at CW.
  (*b*) OFF–RCVR–XMIT at RCVR.
  (*c*) RCVR CHANNEL at any selected channel.
(2) Disconnect the RF signal generator from the radio set, and adjust the VOL control for 0.1-milliwatt (–10 db) noise output.
(3) Connect the RF signal generator, tuned to channel frequency with no modulation, and adjust the output level to 1.0-milliwatt (0 db) audio output.
(4) Repeat the procedures given in (2) and (3) above; readjust if necessary, and note the RF signal generator level.
(5) The product of 100,000 X RF signal generator level noted in (4) above (in volts) will establish the minimum RF signal generator level.
  Example: .20 microvolts X 100,000 = .02 volt.
(6) Adjust RF GAIN to minimum gain (counterclockwise) position.
(7) Repeat the procedures in (3) above and note the RF signal generator level.
(8) The RF signal generator level of (7) above will be equal to or greater than the product of (5) above.

b. Am. Sensitivity Check. Connect the equipment as shown in figure 6-7, and make the am. sensitivity check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
   (*a*) AM-CW at AM.
   (*b*) OFF-RCVR-XMIT at RCVR.
   (*c*) RCVR CHANNEL at selected channel (all six channels will be checked).
(2) Adjust the RF signal generator to approximately 10 microvolts at the selected channel frequency. Modulate the signal 30 percent at 1000 cps.
(3) Turn off the modulation on the RF signal generator, and adjust the VOL control to 0.1-milliwatt (-10 db) noise output.
(4) Turn the modulation on, and adjust the signal generator level to obtain 1.0-milliwatt (0 db) output.
(5) Repeat the procedures in (3) and (4) above; readjust if necessary.
(6) The RF signal generator level will not exceed 22.0 microvolts.
(7) Repeat the procedures given in (1) through (6) above for the remaining five channels.

c. Cw Sensitivity check. Connect the equipment as shown in figure 6-7, and make the cw sensitivity check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
   (*a*) AM-CW at CW.
   (*b*) OFF-RCVR-XMIT at RCVR.
   (*c*) RCVR CHANNEL at any selected channel (all six channels will be checked).
(2) Disconnect the RF signal generator from the radio set, and adjust the VOL control for 0.1-milliwatt (-10 db) noise output.
(3) Connect the RF signal generator, tuned to channel frequency with no modulation, and adjust the output level to obtain 1.0-milliwatt (0 db) audio output.
(4) Repeat the procedures in (2) and (3) above; readjust if necessary.
(5) The RF signal generator level will not exceed 10 microvolts.
(6) Adjust the dc input to 10 volts, and repeat the procedures in (2) through (5) above on channel 1 only.
(7) Adjust the dc input to 17 volts, and repeat the procedures in (2) through (5) above on channel 1 only.
(8) Repeat the procedures given in (1) through (5) above for the five remaining channels.

d. Output Impedance Check. Connect the equipment as shown in figure 6-8, and make the output impedance check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
   (*a*) AM-CW at AM.
   (*b*) OFF-RCVR-XMIT at RCVR.
   (*c*) RCVR CHANNEL at any selected channel.
(2) Set the RF signal generator level at 1000 microvolts.
(3) Tune the RF signal generator, modulated 30 percent at 1000 cps, to channel frequency.
(4) Vary the input impedance of the power meter, and note the setting for maximum output.
(5) The nominal output impedance of the earphone termination will be 600 ohms.

e. Audio Response Check. Connect the equipment as shown in figure 6-9, and make the audio response check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
   (*a*) AM-CW at AM.
   (*b*) OFF-RCVR-XMIT at RCVR.
   (*c*) RCVR CHANNEL at any selected channel.
(2) Using the external audio oscillator, modulate the RF signal generator 30 percent at 1000 cps.
(3) Set the RF signal generator level at 1000 microvolts, and tune to selected channel frequency.
(4) Adjust the VOL control on the AN/TRC-77(*) to 1.0-milliwatt (0 db) reference audio output.
(5) Tune the audio oscillator from 300 cps to 2,500 cps.

(6) The audio output will not drop below –3 db from 300 cps to 2,000 cps, nor below –6 db at 2,500 cps.

f. AGC Distortion Check. Connect the equipment as shown in figure 6–10, amd make the AGC distortion check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) AM–CW at AM.
  (*b*) OFF–RCVR–XMIT at RCVR.
  (*c*) RCVR CHANNEL at any selected channel.
(2) Set the RF signal generator level at 50 microvolts.
(3) Tune the RF signal generator, modulated 30 percent at 1000 cps, to channel frequency.
(4) Adjust the VOL control on the AN/TRC–77(*) to provide 0.1-milliwatt audio output.
(5) Measure the percent of distortion on the distortion analyzer.
(6) The corrected reading will be 15 percent maximum.
(7) Repeat the procedures in (3), (5), and (6) above at each of the following signal generator levels:
160 μv, 500 μv, 1600 μv, .005 volt, .016 volt and .050 volt.

Note. Do not readjust the VOL control at each RF signal generator level.

g. Audio Distortion Check. Connect the equipment as shown in figure 6–11, and make the audio distortion check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) AM–CW at AM.
  (*b*) OFF–RCVR–XMIT at RCVR.
  (*c*) RCVR CHANNEL at any selected channel.
(2) Using the external audio oscillator, modulate the RF signal generator 30 percent at 1000 cps.
(3) Set the RF signal generator level at 1000 microvolts and tune to selected channel frequency.
(4) Adjust the VOL control to 1.0-milliwatt audio output.
(5) Measure the percent of distortion on the distortion analyzer.
(6) The reading will be 10 percent maximum.
(7) Repeat the procedures in (2) through (6) above, modulating the signal generator 30 percent at 300 cps.
(8) Repeat the procedures in (2) through (6) above, modulating the signal generator 30 percent at 2,500 cps.

h. IF Bandwidth Check. Connect the equipment as shown in figure 6–12, and make the IF bandwidth check as follows:

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
  (*a*) AM–CW at CW.
  (*b*) OFF–RCVR–XMIT at RCVR.
  (*c*) RCVR CHANNEL at selected channel (all six channels will be checked).
(2) Disable the bfo by shorting capacitor C68 to ground.
(3) Adjust the RF signal generator to selected channel frequency at a level of 50 microvolts, and note the RF millivolt meter reading.
(4) Increase the RF signal generator input level 6 db; tune the RF signal generator clockwise, noting counter reading, and then counterclockwise, noting counter reading, until the RF millivolt meter reads the same as in (3) above. The difference in frequency between these two points will be a minimum of 5 kc and a maximum of 6 kc.
(5) Repeat the procedures in (3) above.
(6) Increase the RF signal generator input 60 db; tune the RF signal generator clockwise, noting counter reading, and then counterclockwise, noting counter reading, until the RF millivolt meter reads the same as in (5) above. The difference in frequency between these two points will be a maximum of 16 kc.
(7) Repeat the procedures in (1) through (6) above for the five remaining channels.

i. Frequency Stability Check. Connect the equipment as shown in figure 6–13, and make the frequency stability check as follows:

(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
(*a*) AM-CW at AM.
(*b*) OFF-RCVR-XMIT at RCVR.
(*c*) RCVR CHANNEL at any selected channel (all six channels will be checked).
(2) Record the frequency readings from the counter for a period of 5 minutes.
(3) The difference between the highest and lowest frequencies recorded in (2) above will be equal to or less than .008 percent of the nominal channel frequency of the local oscillator

Channel	Nominal frequency	Maximum change allowed
1	3,455 kc	240 cps
2	4,515 kc	325 cps
3	5,555 kc	408 cps
4	6,455 kc	480 cps
5	7,455 kc	560 cps
6	8,455 kc	640 cps

(4) Repeat the procedures in (2) and (3) above for the remaining five channels, using the above chart for maximum allowable change for each channel.

j. Bfo Oscillator Check. Connect the equipment as shown in figure 6-14, and make the bfo oscillator check as follows:
(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:
(*a*) AM-CW at CW.
(*b*) OFF-RCVR-XMIT at RCVR.
(2) Set BFO PITCH, C68, to the center of its range either by lining up the index (0) on the front panel or by observing the position of the capacitor plates; note the frequency (should be approximately 455 kc).
(3) Rotate C68 to maximum capacity (90° ccw from zero position), and note the frequency.
(4) Rotate C68 to minimum capacity (90° cw from zero position), and note the frequency.
(5) The difference in frequency between (2) and (3) above will be 2,500 cycles minimum.
(6) The difference in frequency between (2) and (4) above will be 2,500 cycles minimum.
(7) Rotate C68 to obtain a BFO frequency of 455 kc.
(8) After 5 minutes, the BFO frequency will be 455 kc ±227 cps.

k. Spurious Response Check. Connect the equipment as shown in figure 6-15, and make the spurious response check as follows:
(1) Set the Radio Set AN/TRC-77(*) controls as indicated below:

Note. Two RF signal generators are required to cover the full range of testing. Begin with the AN/URM-25F and switch to the AN/USM-44 for the higher frequencies.

(*a*) AM-CW at CW.
(*b*) OFF-RCVR-XMIT at RCVR.
(*c*) RCVR CHANNEL at channel 1 or channel 6 (both channels will be checked).
(2) Disconnect the RF signal generator from the radio set, and adjust the VOL control for 0.1-milliwatt (-10 db) noise output.
(3) Connect the RF signal generator, tuned to channel frequency with no modulation, and adjust the output level to 1.0-milliwatt (0 db) audio output.
(4) Repeat (2) and (3) above; readjust if necessary.
(5) Note the RF signal generator level.
(6) Adjust the RF signal generator output to .010 volt at 300 kc.
(7) Slowly tune the RF signal generator through the range of 300 kc to 80 mc.
(8) Wherever there is a response, the output level of the RF signal generator will be adjusted to produce 1.0-milliwatt (0 db) audio output.
(9) Note the frequencies and RF signal generator levels required for 1.0-milliwatt output (see (8) above).

Note. After each response, readjust the signal generator level to .010 volt.

(10) The image frequency (the channel frequency plus twice the IF frequency) will be at least 35 db greater than the reading obtained in (5)

above. All other responses will be at least 40 db greater than the reading obtained in (5) above.

(11) Repeat the procedures in (1) through (10) above for the remaining channel.

l. Sound Pressure Level Check. Connect the equipment as shown in figure 6–16, and make the sound pressure level check in sound room as follows:

Note. The test equipment used to conduct the test consists of the following:
General Radio 1521A: Level Recorder.
General Radio 1554A: Frequency Analyzer.
General Radio 1551B: Sound Level Meter.
Shure 98108: Microphone.

(1) Set the Radio Set AN/TRC–77(*) controls as indicated below:
(*a*) OFF–RCVR–XMIT at XMIT.
(*b*) ANT. TUNE adjusted for max. output.
(*c*) XMTR CHANNEL at channel 6.

(2) Position the microphone in a perpendicular plane 3 feet from the radio set front panel.

(3) Close the key and seal the sound room.

(4) Record the sound pressure levels.

(5) The sound pressure levels noted in (4) above will not exceed the following:

Frequency	Maximum sound pressure levels (db reference 0.00002 microbar)
20–75	60
75–150	51
150–300	43
300–600	37
600–1,200	32
1,200–2,400	30
2,400–4,800	28
4,800–5,600	27

(6) Repeat the procedures in (3) through (5) above with the microphone positioned in a perpendicular plane 3 feet from the radio set case side.

(7) Repeat the procedures in (3) through (5) above with the microphone positioned in a perpendicular plane 3 feet from the radio set case top.

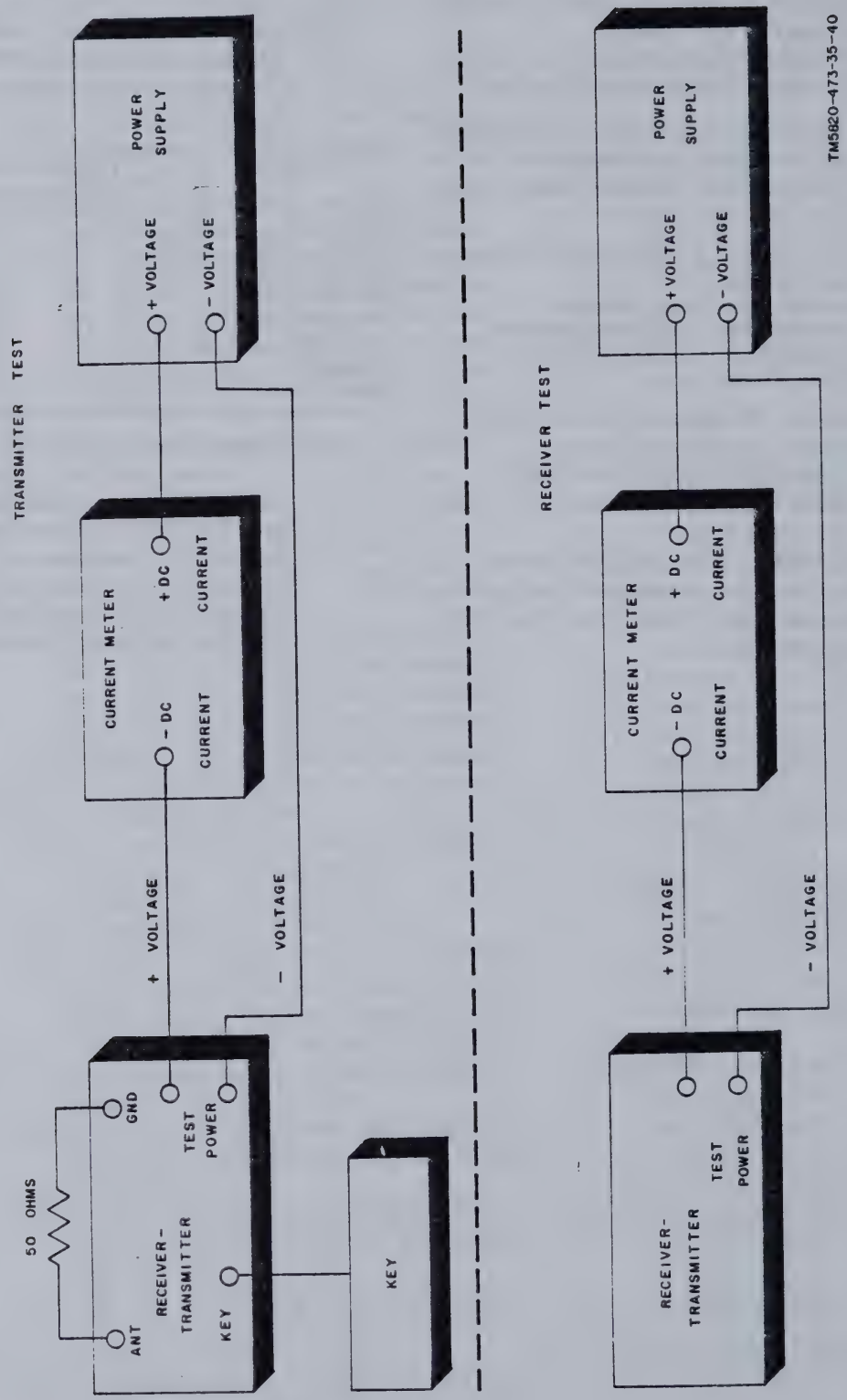


Figure 6-1. Battery current drain test.

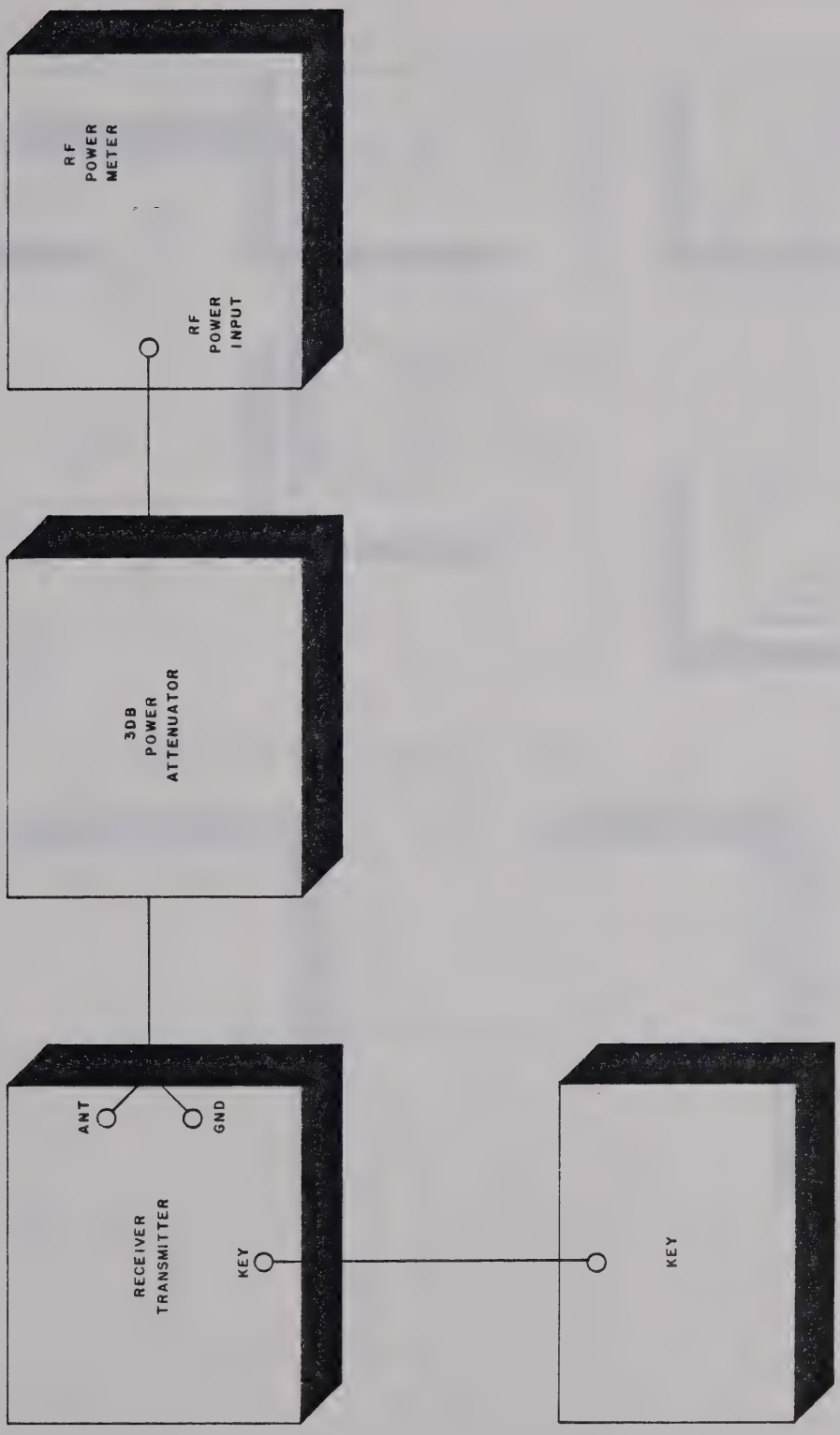


Figure 6–2. Transmitter power output test.

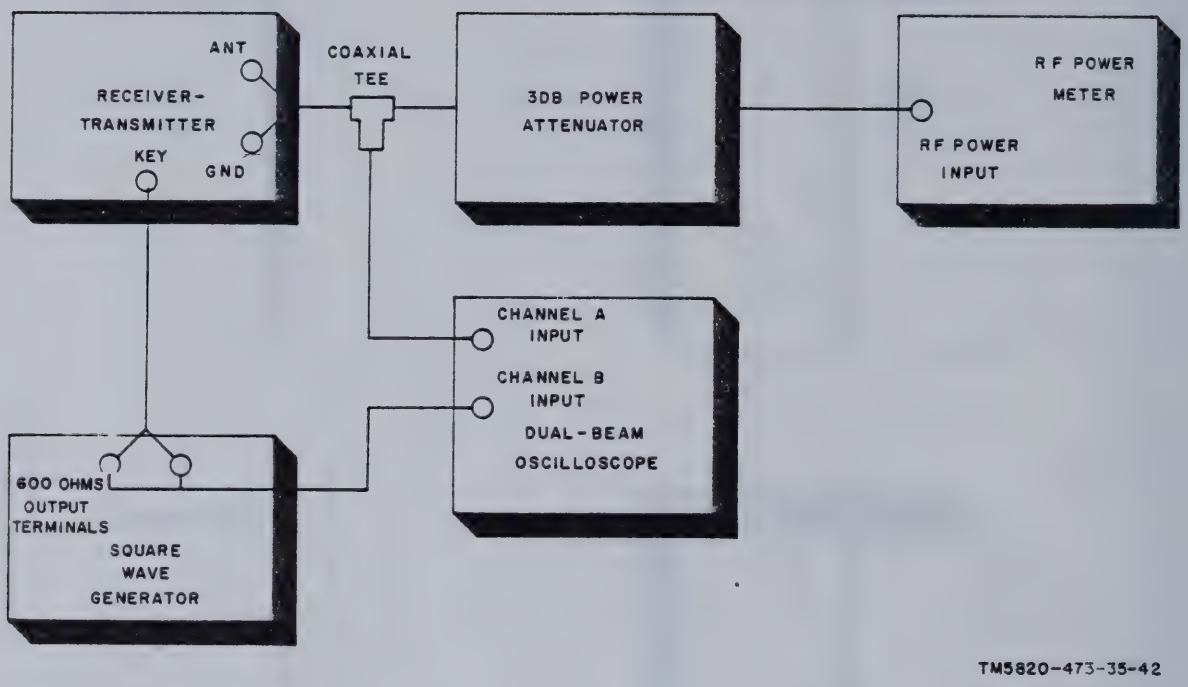


Figure 6-8. Transmitter keyer waveform test.

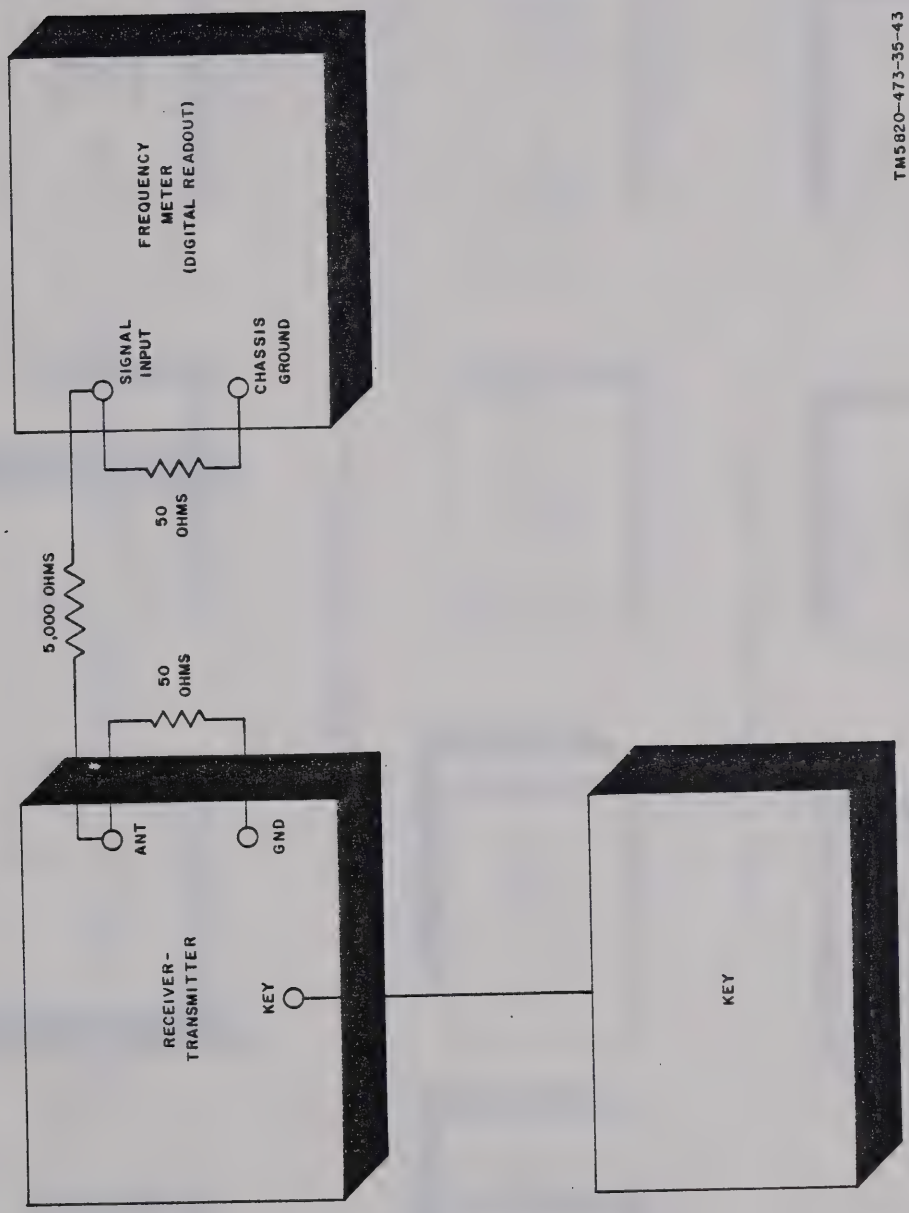


Figure 6-4. Transmitter frequency stability test.

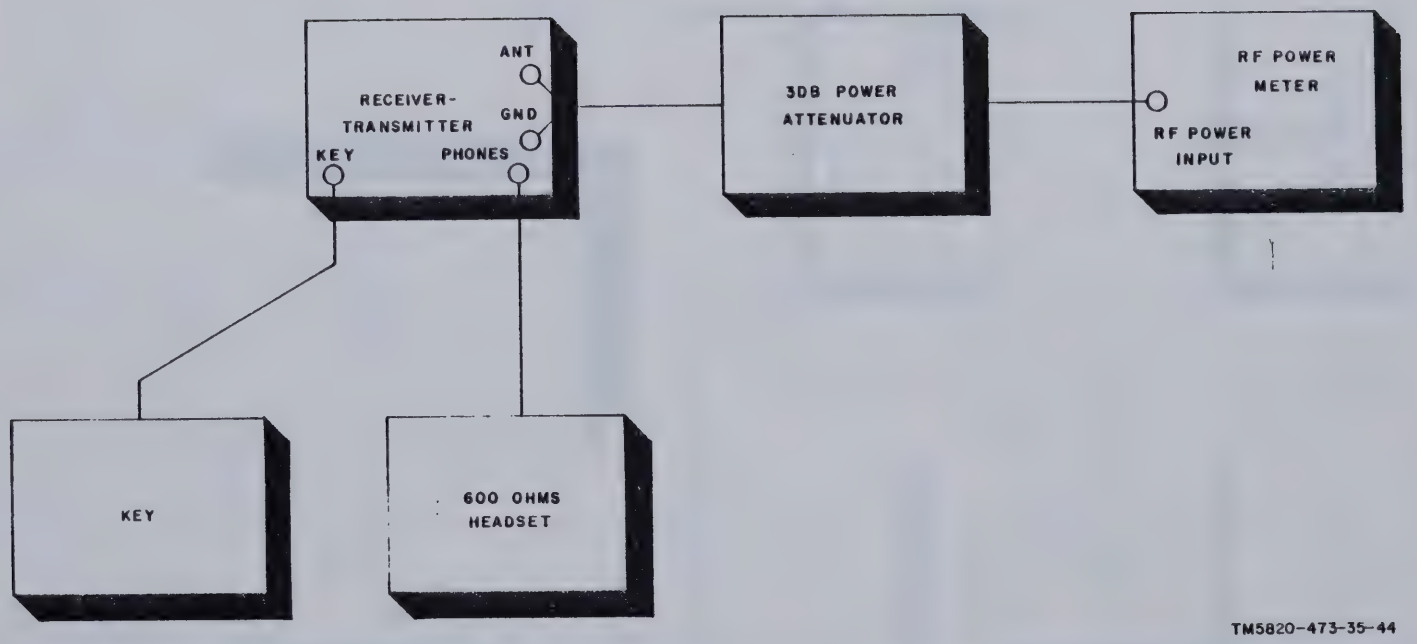


Figure 6-5. Transmitter sidetone oscillator test.

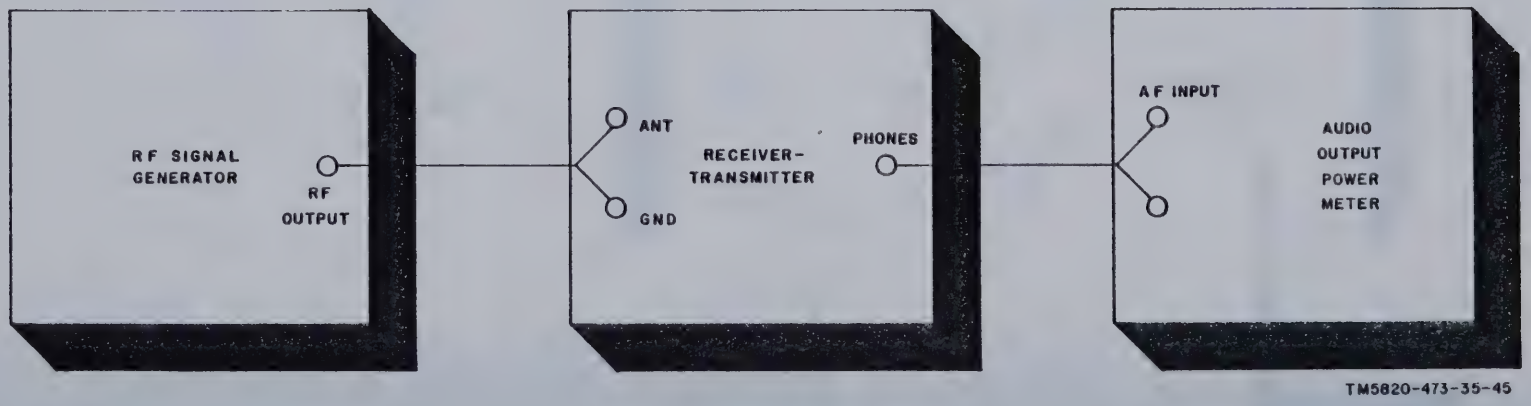


Figure 6-6. Receiver RF gain test.

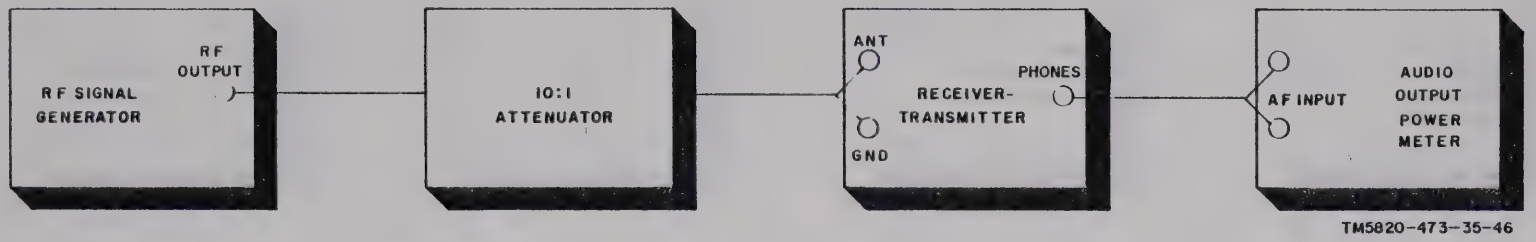


Figure 6-7. Receiver sensitivity test.

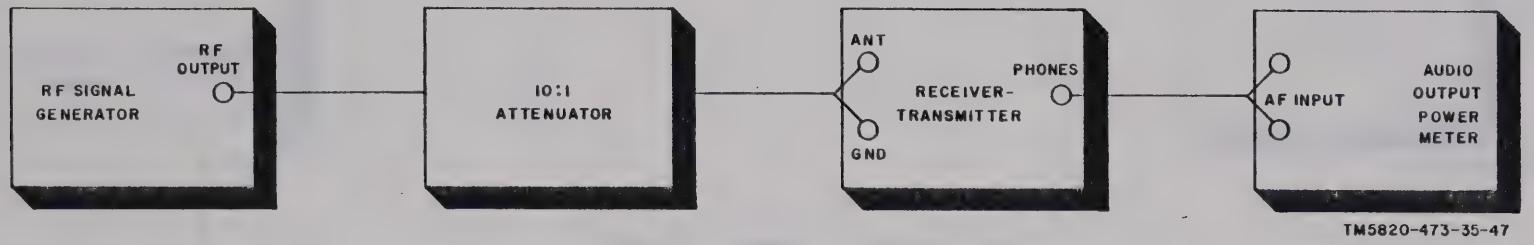


Figure 6-8. Receiver output impedance test.

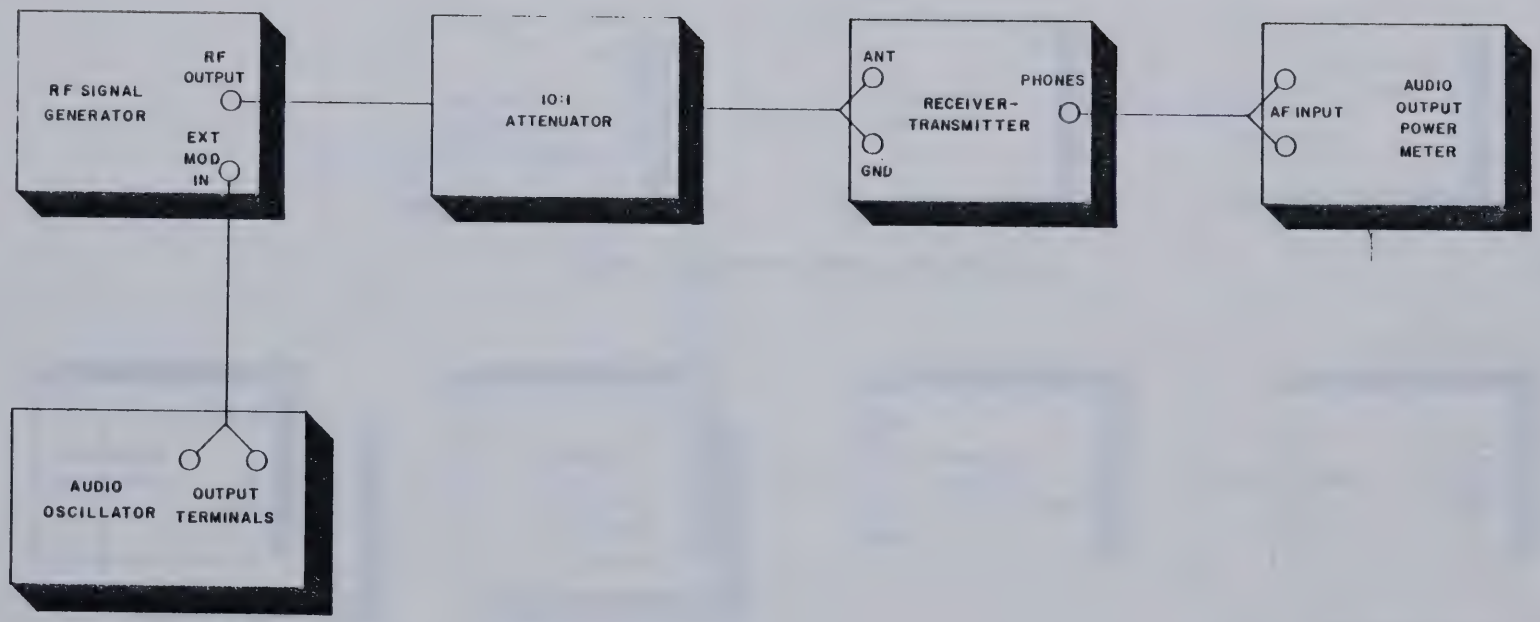


Figure 6-9. Receiver audio response test.

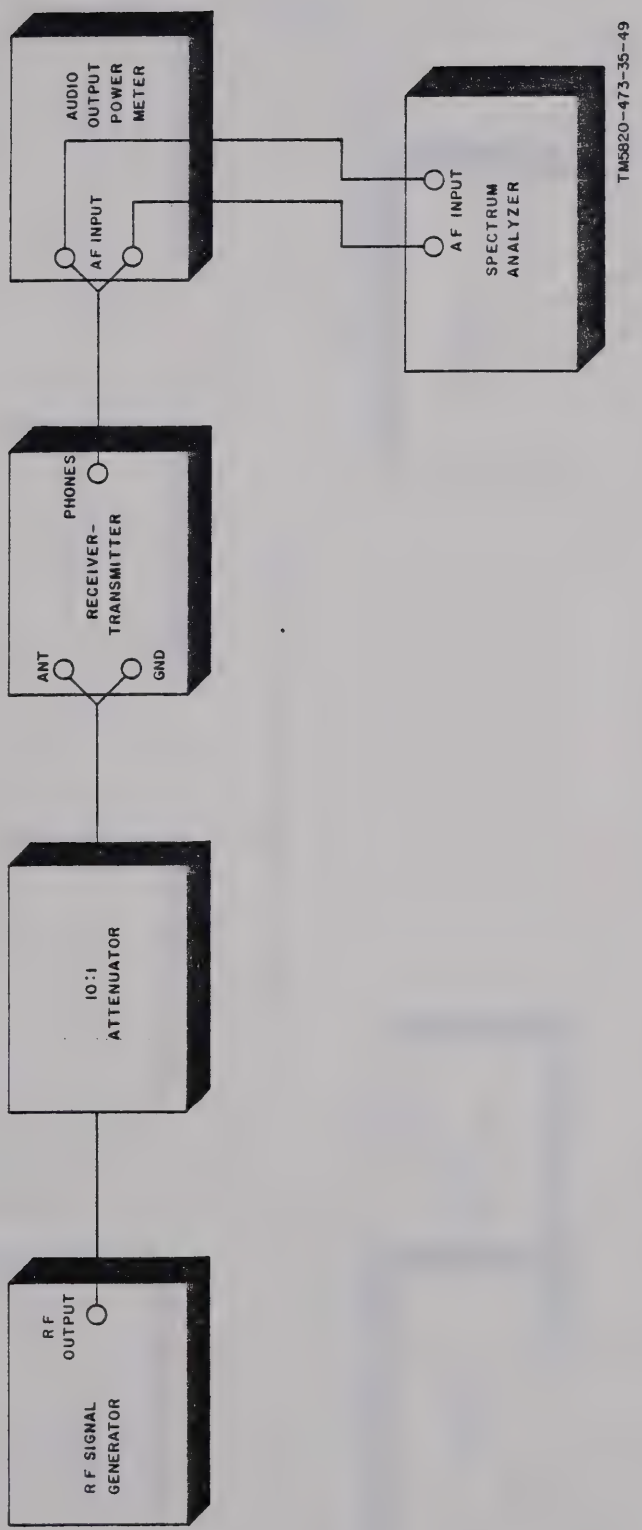


Figure 6-10. Reciever age distortion test.

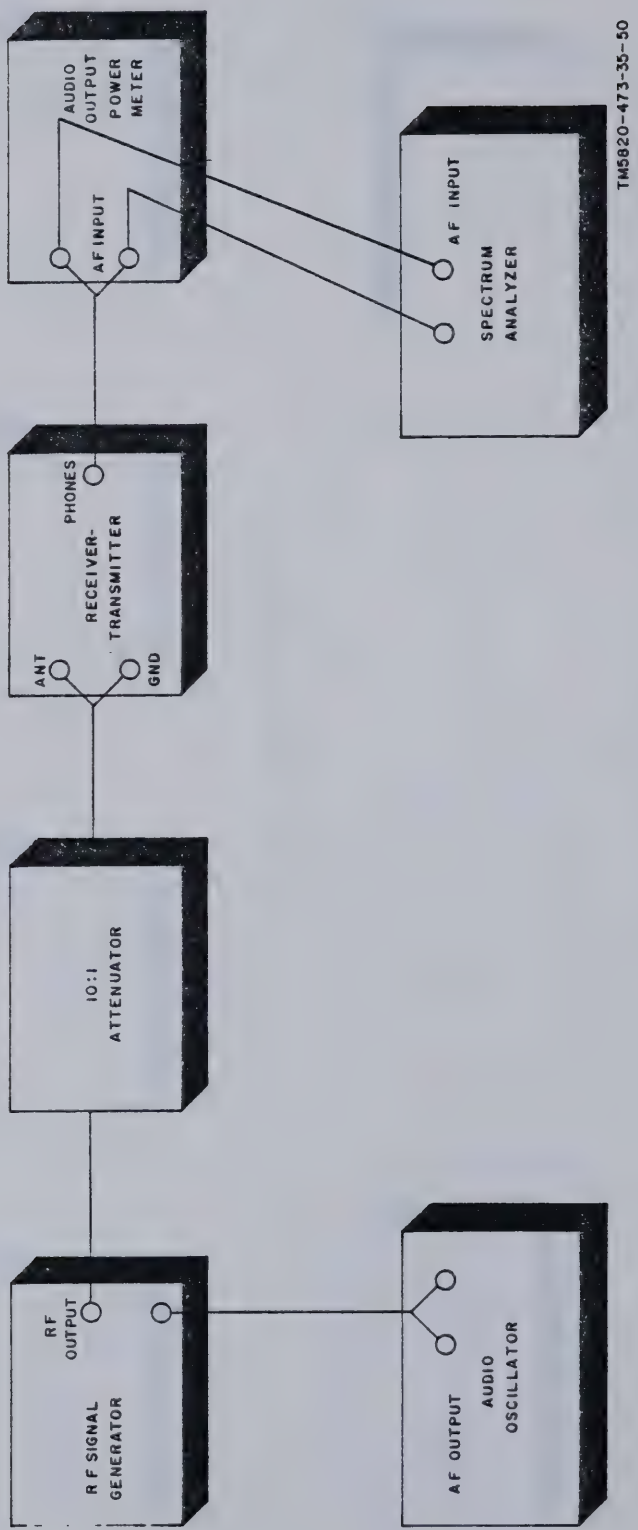


Figure 6-11. Receiver audio distortion test.

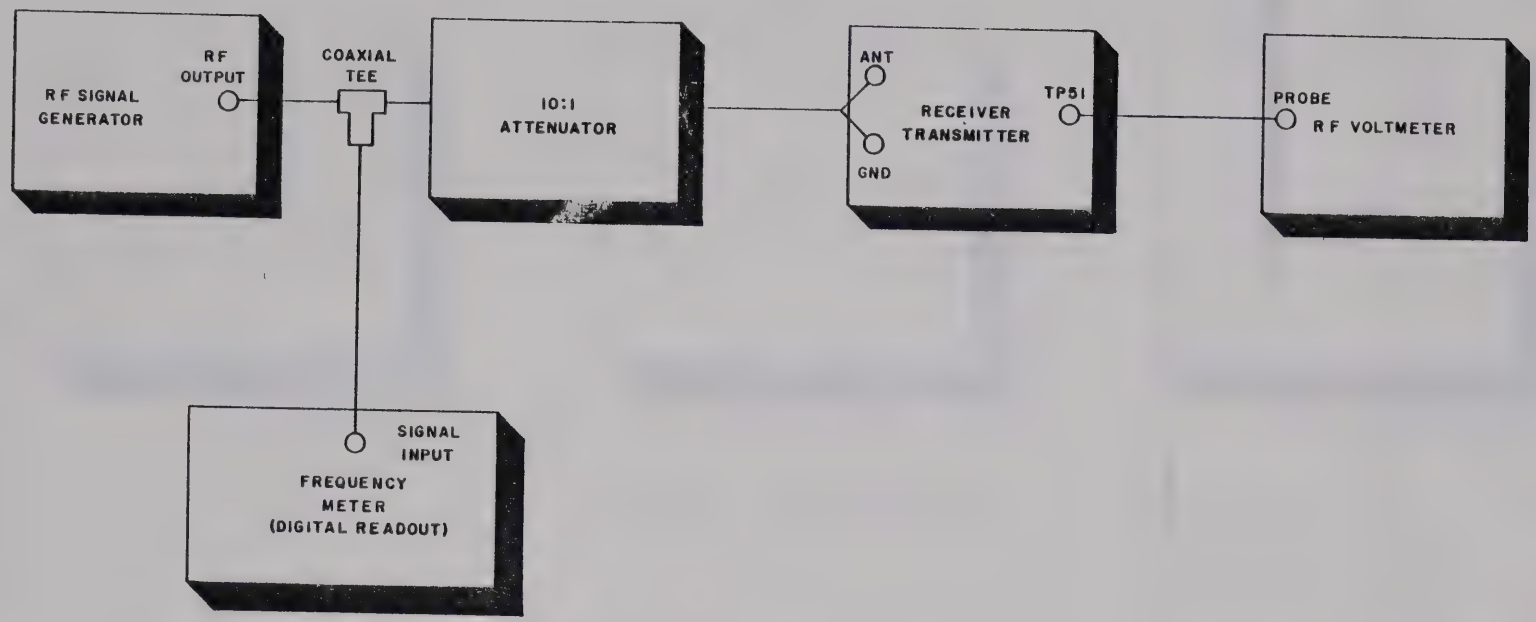


Figure 6–12. Receiver IF bandwidth test.

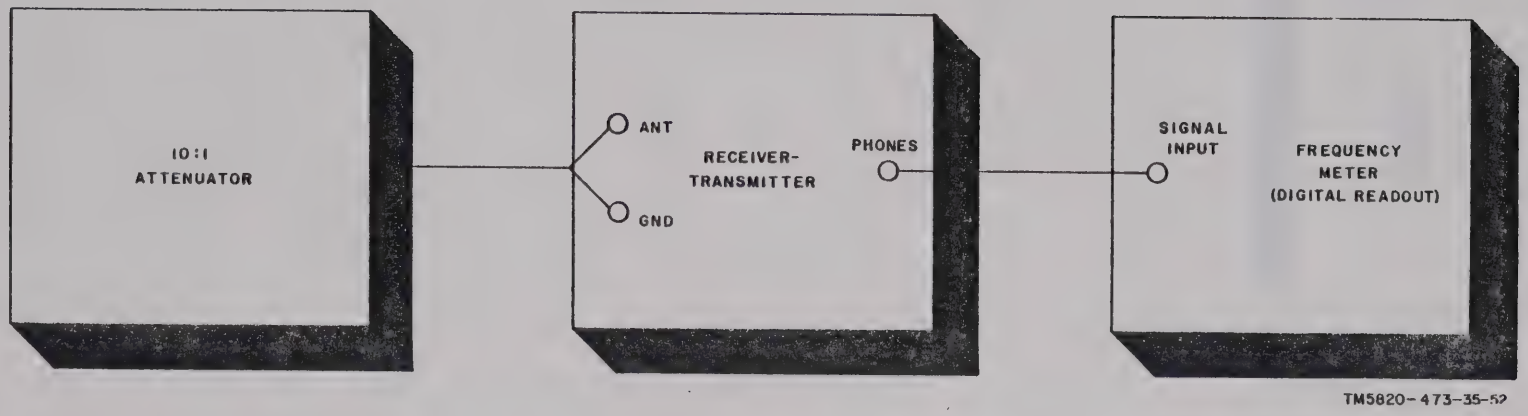


Figure 6–13. Receiver frequency stability test.

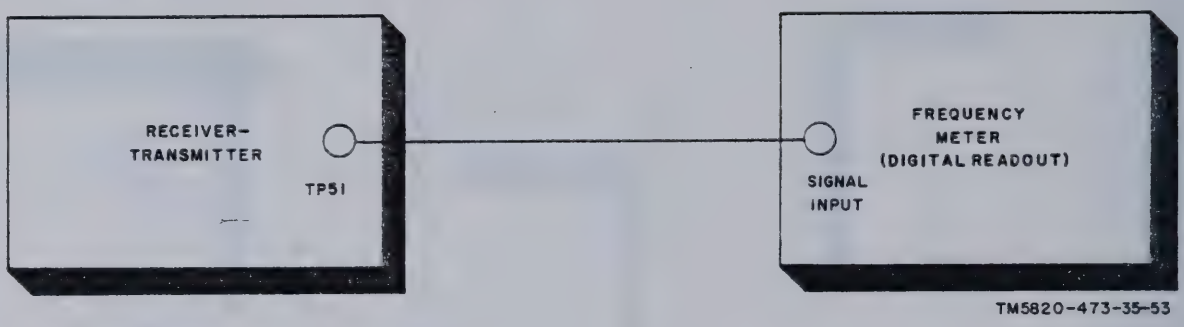


Figure 6-14. Receiver bfo oscillator test.

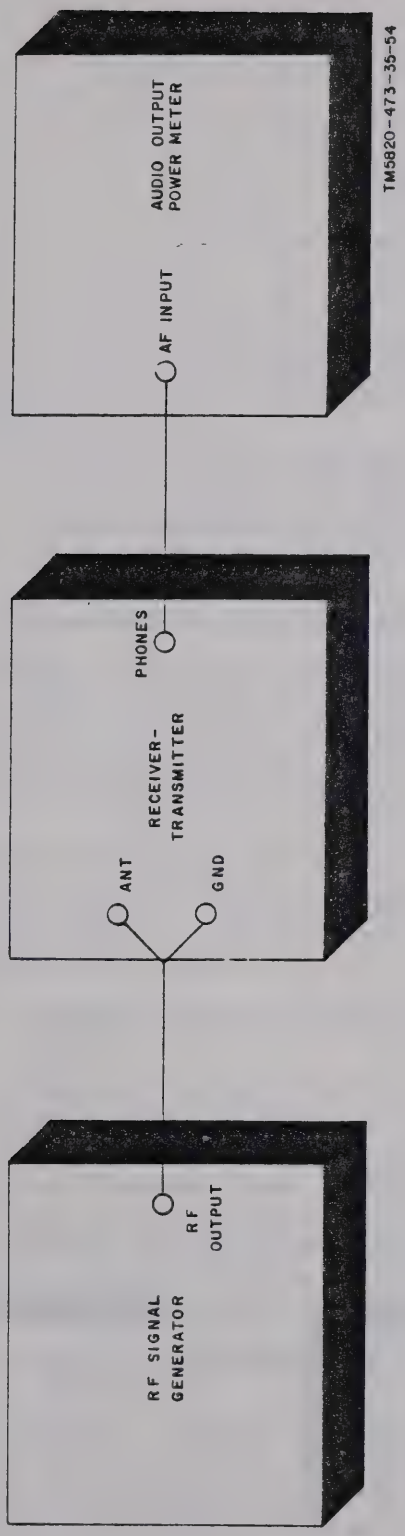


Figure 6-15. Spurious response test.

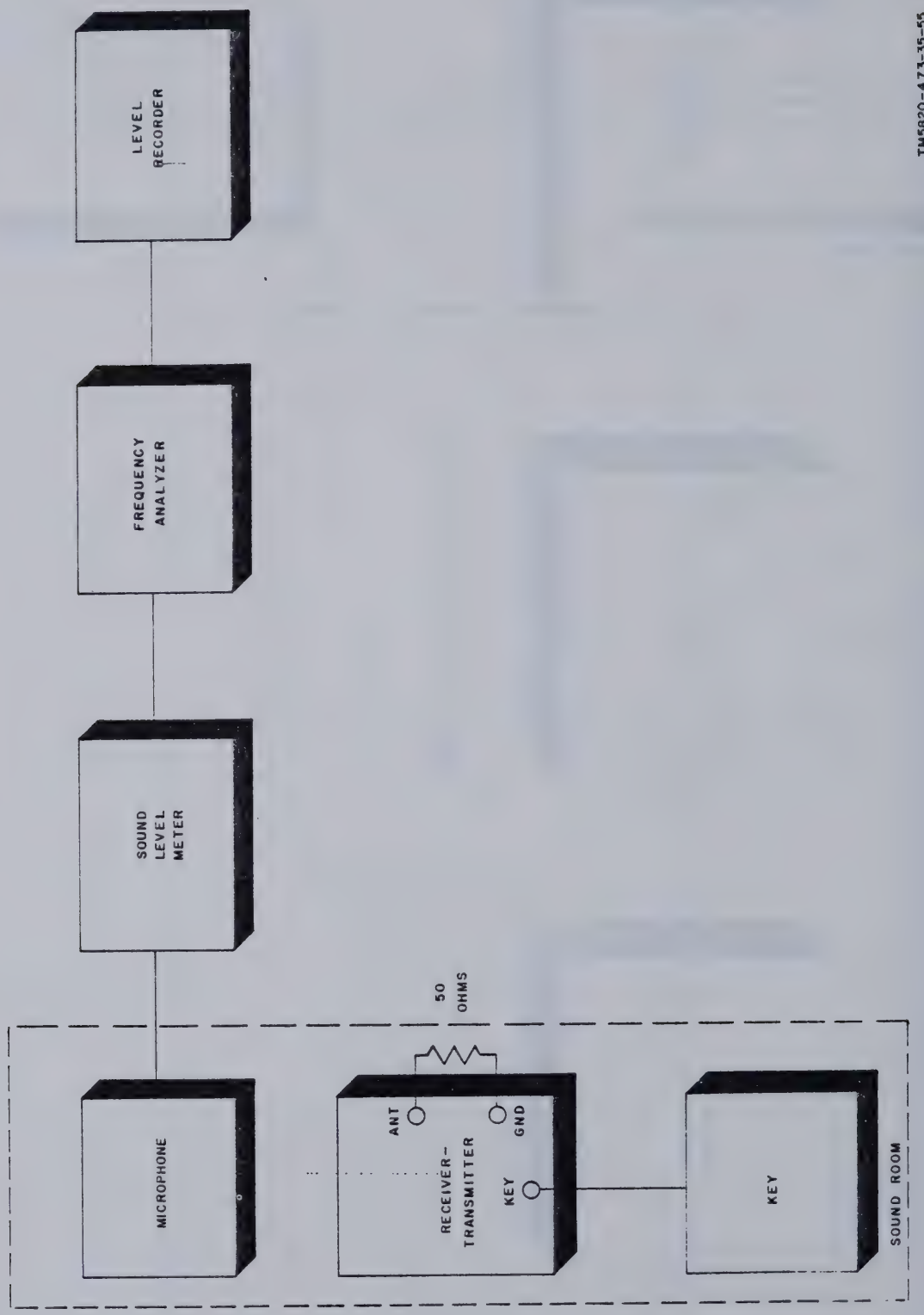


Figure 6–16. Sound pressure level test.

CHAPTER 7

AUXILIARY EQUIPMENT

7-1. General

This chapter contains instructions appropriate for direct support, general support, and depot maintenance of the following battery chargers:

a. AC Battery Charger PP-3251/TRC-77.
b. AC Battery Charger PP-3251A/TRC-77.
c. DC Battery Charger PP-3252/TRC-77.
d. DC Battery Charger PP-3252A/TRC-77.

7-2. Internal Differences in Models

There are no internal differences between AC Battery Chargers PP-3251/TRC-77 and PP-3251A/TRC-77, and no internal differences between DC Battery Chargers PP-3252/TRC-77 and PP-3252A/TRC-77.

7-3. System Application

The AC and DC battery chargers are used to charge Battery Assemblies BB-447/TRC-77 and BB-447A/TRC-77.

7-4. AC Battery Charger PP-3251(*)/TRC-77

AC Battery Charger PP-3251(*)/TRC-77 converts alternating current into direct current. When an ac source of from 70 to 270 volts, within a frequency range of from 40 to 400 cps, is applied to the input connector, the output connector delivers 12 volts dc for external use. For complete circuit details, refer to the overall schematic diagram (fig. 7-1).

7-5. Input Circuitry Signal Path (fig. 7-1)

a. When the ac battery charger is operating under normal conditions, ac power is applied to line plug P1, through the line cord, and through input connectors P2 and J2.

b. If overload circuit breaker CB2 and mechanical timer S4 have their respective line contacts closed, the normal path for power distribution of one-half cycle is from connector J2 pin A through closed contacts (A and B) of circuit breaker CB2, through the rotary contact of switch S3, and into one of the stationary contactors (1 through 11), through the primary winding of transformer T1, through the closed contacts of timer S4, through fuse F1, and back to the other side of input connector J2 at pin B.

c. During full cycles of operation, power is inductively coupled from the input circuitry to the output circuitry through transformer T1.

d. Diode rectifier CR1 through CR4 converts the ac current to dc current.

7-6. Analysis of Operation (fig. 7-1)

a. Automatic Timer Switch S4. The electrical contacts of mechanical timer S4 are connected to one side of the primary windings of transformer T1. When the timer is functioning, the electrical contacts are closed, allowing power to be applied to the transformer. At the end of the time limit (externally preset), the electrical contacts automatically open, and power transfer across transformer T1 is disabled, causing the charger to discontinue operation.

b. Transistor Controlled Overload Circuit. The transistor controlled overload circuit consists of Zener control diode CR5 and electromagnetic circuit breaker CB2. When the voltage at the junction of resistor R4 and circuit breaker CB1 reaches 42 volts dc, control diode

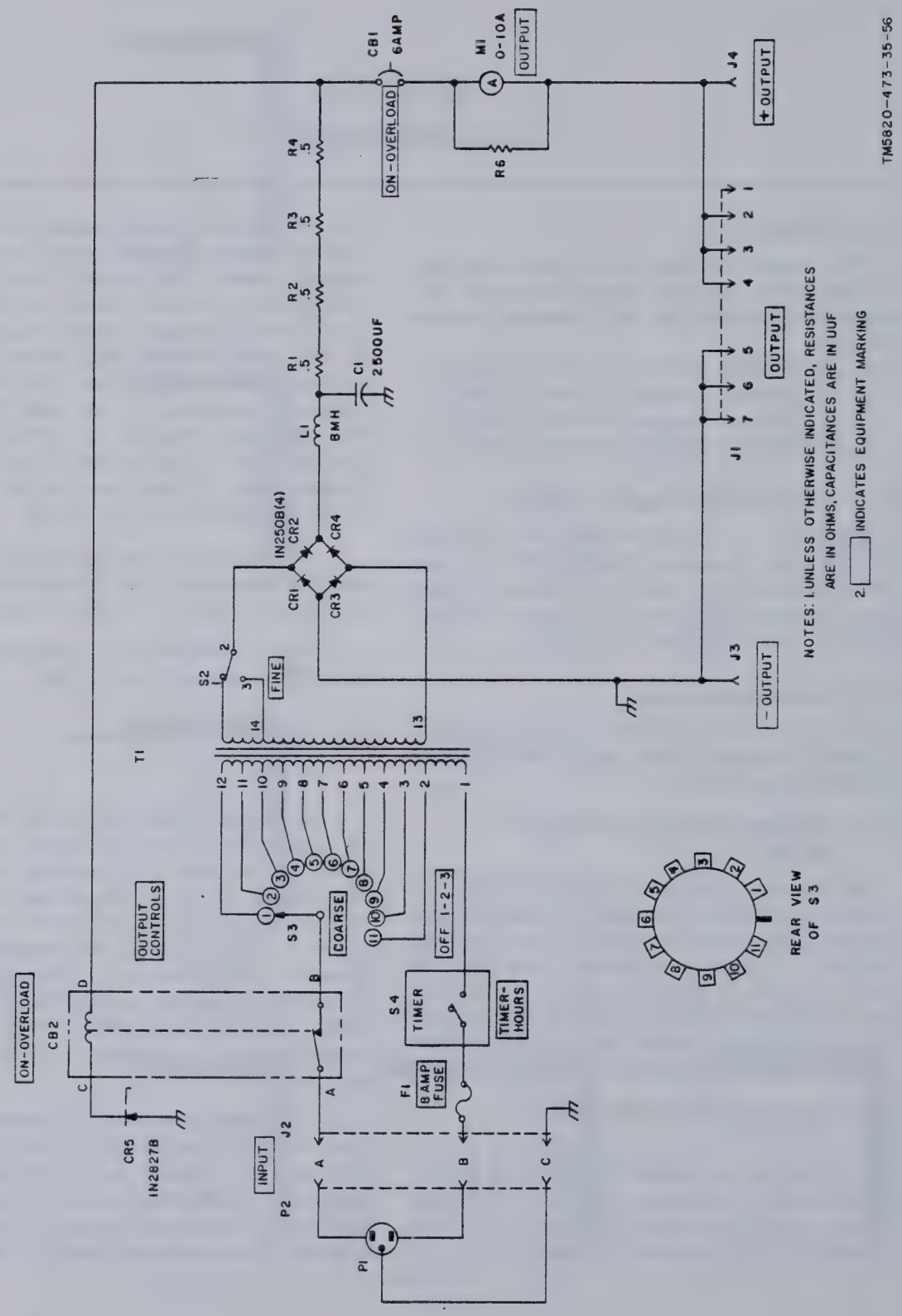


Figure 7-1. Ac battery charger, schematic diagram.

CR5 breaks down and presents a low impedance to the power output circuit causing a heavy current to travel through the coil portion of circuit breaker CB2. This results in the opening of the breaker contacts (A and B) and disrupts input power normally applied to the primary of transformer T1 through switch S3.

c. Selection Control Circuitry. The selection and control circuit consist of COARSE selection switch S3 and FINE selection switch S2. Both switches control the coupling impedance of transformer T1. Switch S3 operates in the primary windings, while switch S2 functions in the secondary windings. The CORASE selection switch is capable of being positioned to 1 of 11 switch positions.

d. Filter Network. An ac ripple suppression and a filter network composed of inductor L1, electrolytic capacitor C1, and series resistors R1 through R4 combine to provide a steady current output and suppression of input power surges. Inductor L1, in conjunction with resistors R1 through R4, takes care of the smoothing action, while capacitor C1 eliminates any sudden changes in current.

e. Meter Circuit. Meter M1, in conjunction with shunt resistor R6, provides a means for viewing the current applied to the external battery during the charging cycle. Shunt resistor R6 bypasses excessive current to prevent damage to the meter movement.

f. Test Jacks. Power monitor test jacks J3 and J4 provide an easy means of measuring the output voltage with a multimeter. The test jacks are provided as a maintenance aid in troubleshooting the charger.

7-7. Troubleshooting Test Setup

There are no special test equipment connections or test equipment necessary for troubleshcoting the ac battery charger.

7-8. Isolating Trouble Within Circuit

Use one or more of the following techniques to isolate the faulty component.

a. General. Localize the trouble to a circuit through operational checks; then isolate the defective part by voltage measurements or continuity measurements.

b. Schematic Diagram. Use the schematic diagram (fig. 7-1) to circuit trace and isolate the faulty part.

7-9. Replacement of Parts

All authorized replacement parts within the ac battery charger can be easily removed by unsoldering leads or by removing screws and require no special replacement procedures other than the standard procedures outlined in the general parts replacement techniques in chapter 4. Refer to figure 7-2 for parts location.

7-10. Additional Troubleshooting Data

The resistance values of transformer T1 and inductor L1 are listed below.

Transformer or indicator	Terminals	Ohms
T1	15-14	0 ohm
	15-13	0.1 ohm
	13-14	0.1 ohm
	1-2	0.6 ohm
	1-3	0.6 ohm
	1-4	0.7 ohm
	1-5	0.9 ohm
	1-6	1.1 ohm
	1-7	1.2 ohm
	1-8	1.6 ohm
	1-9	1.9 ohm
	1-10	2.3 ohms
	1-11	2.8 ohms
	1-12	3.4 ohms
L1	----	0.2 ohm

7-11. Dc Battery Charger PP-3252(*)/TRC-77

The dc battery charger consists of a 1-ohm current-limiting series resistor. With this charger, the battery is charged by the electrical system on the 24- to 28-volt vehicle. Refer to the schematic diagram (fig. 7-3) for maintenance information.

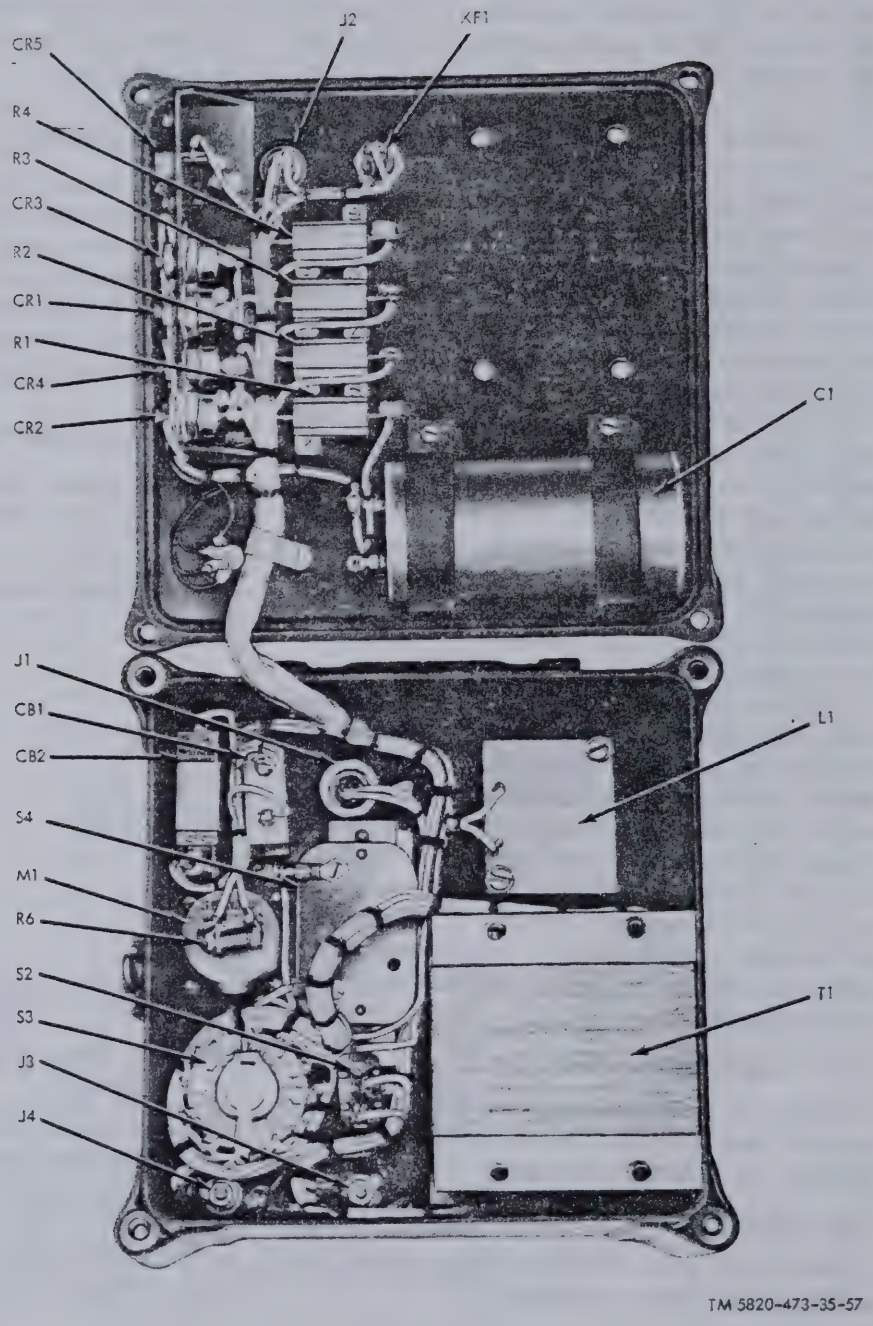


Figure 7-2. Ac battery charger parts location.

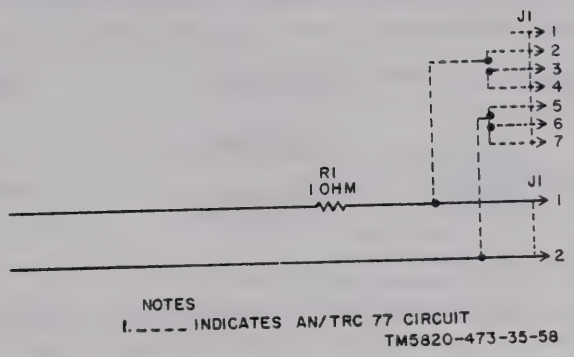
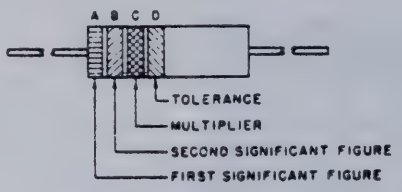


Figure 7-3. Dc battery charger, schematic diagram.

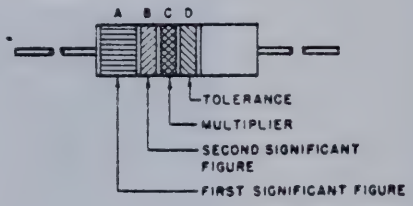
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS

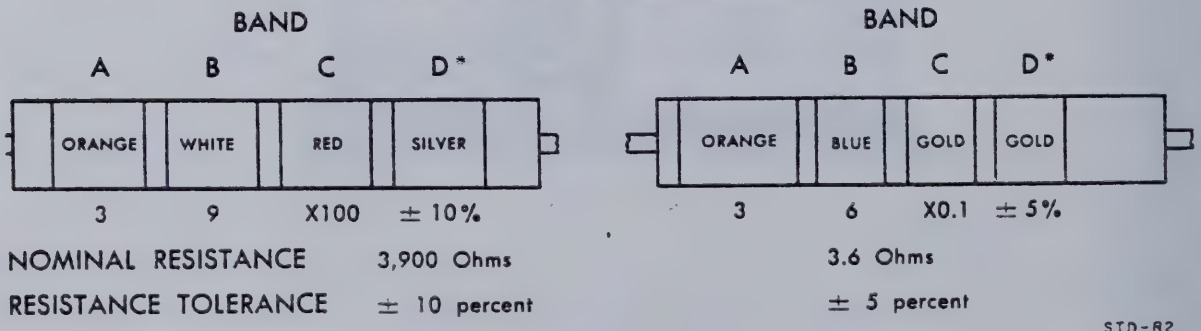


BAND A— Double Width Signifies Wire-wound Resistor

COLOR CODE TABLE

BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING



*If Band D is omitted, the resistor tolerance is ±20%, and the resistor is not Mil-Std.

Figure 7–4. Color code marking for MIL–STD resistors.

APPENDIX I.

REFERENCES

Following is a list of references applicable and available to the direct and general support maintenance repairmen of Radio Sets AN/TRC-77(*):

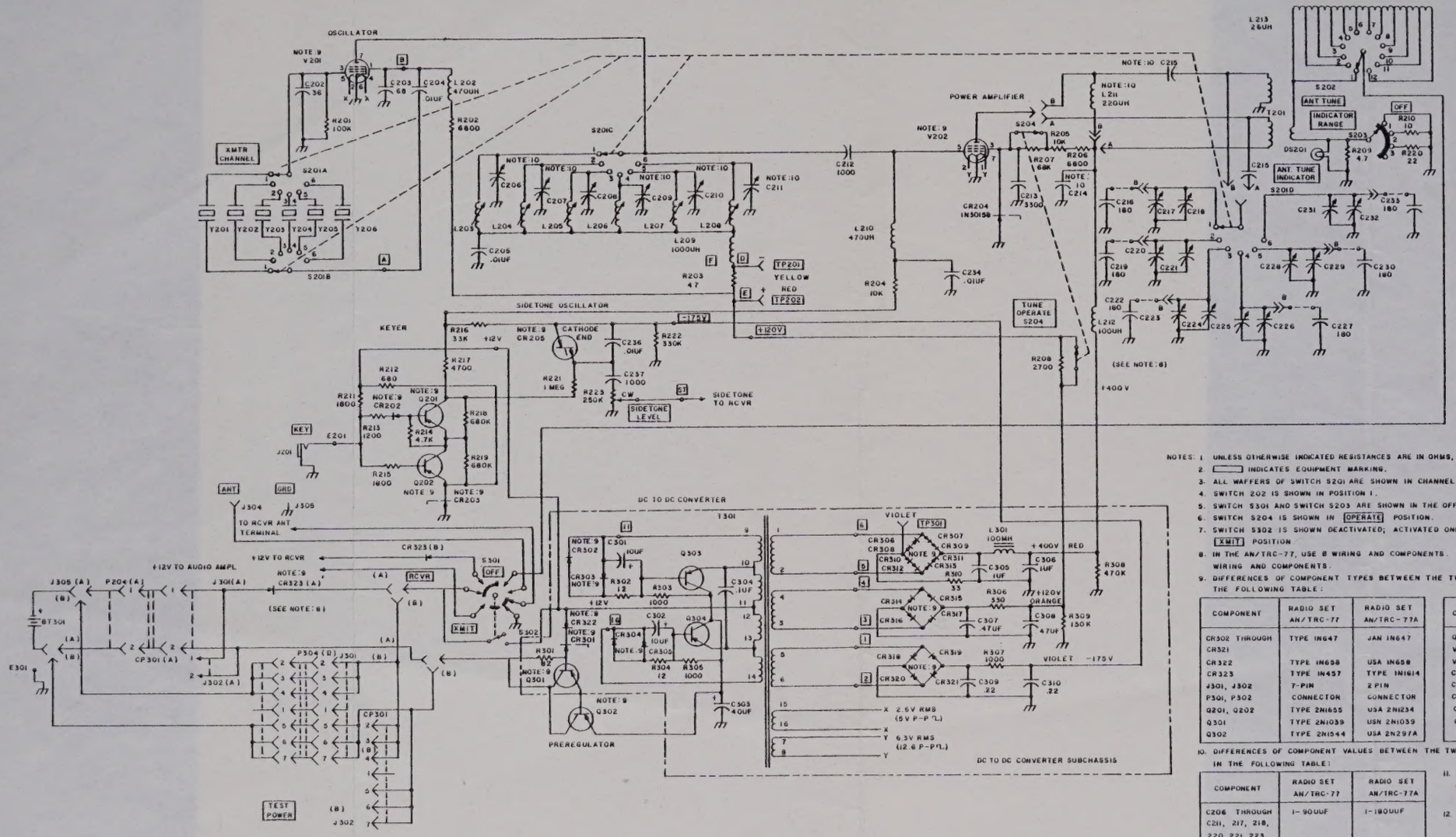
SB 11-549	Additions and Deletions to Tool Kit, Electronic Equipment, TK-100/G, FSN 5180-605-0079
TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus-Resistant Treatment
TM 11-5017	Output Meters TS-585A/U, TS-585B/U, TS-585C/U, and TS-585D/U
TM 11-5057	Frequency Meter AN/USM-26
TM 11-5097	Spectrum Analyzers TS-723A/U, TS-723B/U, TS-723C/U, and TS-723D/U
TM 11-5134-15	Organizational, DS, GS, and Depot Maintenance Manual: Signal Generators SG-299/U, SG-299A/U, SG-299B/U, and SG-299C/U
TM 11-5527	Multimeters TS-352/U, TS-352A/U, and TS-352B/U
TM 11-5551E	RF Signal Generator AN/URM-25F
TM 11-6625-200-12	Operator and Organizational Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, and ME-26C/U
TM 11-6625-261-12	Operator's and Organizational Maintenance Manual: Audio Oscillators TS-382A/U, TS-382B/U, TS-382D/U, TS-382E/U, and TS-382F/U
TM 11-6625-274-35	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U
TM 11-6625-320-12	Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U, and ME-30E/U
TM 11-6625-446-15	Operator, Organizational, Field and Depot Maintenance Manual: Wattmeter AN/URM-120
TM 11-6625-524-14	Operator, Organizational, and Field Maintenance Manual: Voltmeter, Electronic AN/URM-145
TM 11-6625-535-15	Organizational, DS, GS, and Depot Maintenance Manual: Oscilloscope AN/USM-140A
TM 11-6625-539-15	Operator, Organizational, Field and Depot Maintenance Manual: Test Sets, Transistor TS-1836/U

INDEX

	Paragraph	Page
AC Battery Charger PP-3251(*)/TRC-77	7-1	7-1
Additional troubleshooting data, ac battery charger	7-10	7-3
AGC test, general support repair	4-14	4-13
Am. sensitivity check, depot overhaul standards	6-7*b*	6-4
Am. sensitivity test, general support repair	4-11	4-11
Applicability, depot overhaul standards	6-1	6-1
Applicable references, depot overhaul standards	6-2	6-1
Audio amplifier gain test	4-20	4-14
Audio distortion check, depot overhaul standards	6-7*g*	6-5
Audio response check, depot overhaul standards	6-7*e*	6-4
Audio response test	4-18	4-14
Automatic timer switch S4, AC battery charger	7-6*a*	7-1
Auxiliary equipment	7-1	7-1
AGC distortion check, depot overhaul standards	6-7*f*	6-5
Battery current drain check, receiver depot overhaul standards	6-5*a*	6-2
Battery current drain check, transmitter depot overhaul standards	6-5*b*	6-2
Battery current drain test, general support	5-4	5-5
Beat frequency oscillator output and range test	4-21	4-14
Bfo oscillator check depot overhaul standards	6-7*j*	6-6
Block diagrams, radio set	1-4	1-2
Checking for short circuit before applying power, troubleshooting	2-4	2-4
Circuit analysis, ac battery charger	7-6	7-1
Conditions for measurements, direct support troubleshooting	2-8*b*	2-10
Conditions for measurements, general support troubleshooting	4-5*b*	4-4
Cw sensitivity check, depot overhaul standards	6-7*c*	6-4
Cw sensitivity test, general support repair	4-12	4-11
DC Battery Charger PP-3252(*)/TRC-77	7-11	7-3
Dc converter minor test point chart, direct support troubleshooting	2-8*c*(5)	2-11
Field tuning procedures, receiver tuning	3-7*b*	3-12
Field tuning procedures, transmitter tuning	3-7*a*	3-9
Filter network, ac battery charger	7-6*d*	7-3
First IF amplifier neutralization test	4-23	4-15
Frequency stability check, receiver depot overhaul standards	6-7*i*	6-5
Frequency stability check, transmitter depot inspection standards	7-6*c*	7-3
Front end alignment, general support repair	4-22	4-14
General maintenance information, general support troubleshooting	4-1	4-1
General parts replacement techniques	3-1	3-1
General support repair procedures	4-6	4-7
General test requirements, depot overhaul standards	6-4	6-2
General troubleshooting techniques	2-1	2-1
IF amplifier gain test	4-19	4-14
IF and af voltage chart, general support troubleshooting	4-5*c*(2)	4-6
IF bandwidth check, depot overhaul standards	6-7*h*	6-5
IF bandwidth test	4-17	4-13
Image rejection, IF rejection and spurious signal rejection test	4-13	4-13
Input circuitry signal path, ac battery charger	7-5	7-1

	Paragraph	Page
Intermittent troubles, troubleshooting	2-2*d*(4)	2-3
Internal differences in models	1-2	1-1
Internal differences in models, ac battery charger	7-2	7-1
Isolating trouble within circuit, ac battery charger	7-8	7-3
Isolating trouble within stage	2-7	2-10
Isolation, general support troubleshooting	4-4	4-4
Isolation, troubleshooting	2-2*d*	2-2
Keyer waveform check, depot overhaul standards	6-6*b*	6-3
Localizing troubles	2-6	2-5
Major test points, troubleshooting	2-2*d*(3)	2-2
Meter circuit, ac battery charger	7-6*e*	7-3
Minor test point charts, direct support troubleshooting	2-8*c*	2-10
Minor test points, general support troubleshooting	4-5	4-4
Minor test points, troubleshooting	2-2*c*(1)	2-2
Modification work orders, depot overhaul standards	6-2*c*	6-1
Organization, troubleshooting procedures	2-2	2-1
Oscillator and keyer minor test point chart, direct support troubleshooting	2-8*c*(1)	2-10
Output impedance check, depot overhaul standards	6-7*d*	6-4
Physical tests and inspection, general support	5-3	5-2
Power amplifier minor test point chart, direct support troubleshooting	2-8*c*(2)	2-11
Power output check, depot overhaul standards	6-6*a*	6-2
Power supply connections, test setup	2-5	2-5
Preliminary testing procedures	3-6	3-9
Preregulator minor test point chart, direct support troubleshooting	2-8*c*(3), (4)	2-11
Printed circuit board repairs, general support	4-7	4-7
Receiver:		
Agc distortion test, general support	5-13	5-25
Audio distortion test, general support	5-14	5-27
Audio response test, general support	5-12	5-23
Bfo oscillator test, general support	5-17	5-33
Blocking, cw position test	4-15	4-13
Frequency stability test, general support	5-16	5-31
IF bandwidth test, general support	5-15	5-29
Output impedance test, general support	5-11	5-21
RF gain test, general support	5-9	5-15
Section troubleshooting chart, general support	4-2	4-1
Sensitivity test, general support	5-10	5-17
Removal of defective printed circuit components, general support repair	4-7*a*	4-7
Repair standards, depot overhaul standards	6-2*a*	6-1
Repairs and tuning	3-1	3-1
Replacement:		
Component, ac battery charger	7-9	7-3
Components, dc converter assembly subchassis	3-4	3-4
Components, oscillator and keyer assembly subchassis	3-2	3-1
Components, power amplifier assembly subchassis compartment	3-3	3-4
Components, receiver front end assembly, general support repair	4-8	4-7
Components in receiver IF and af assembly general support repair	4-9	4-9
Replacement, printed circuit components, general support repair	4-7*b*	4-7
Resistance measurements, troubleshooting	2-2*d*(2)	2-2
RF front end voltage chart, general support troubleshooting	4-5*c*(1)	4-5
RF GAIN check, depot overhaul standards	6-7*a*	6-3
RF GAIN control test	4-16	4-13
Selection control circuitry, AC battery charger	6-6*c*	6-3
Short circuit tests, troubleshooting	2-4*d*	2-4
Sidetone oscillator check, depot overhaul standards	6-6*d*	6-3
Signal substitution, general support troubleshooting	4-3	4-3

Sound pressure level check, depot overhaul standards	6-7*l*	6-7
Spurious response check, depot overhaul standards	6-7*k*	6-6
System applications, ac battery charger	7-3	7-1
Systems applications, Radio Set AN/TRC-77(*)	1-3	1-2
Technical publications depot overhaul standards	6-2*b*	6-1
Theory:		
Ac battery charger	7-4	7-1
Receiver section	1-5*a*	1-4
Transmitter section	1-5*b*	1-8
Test equipment and tools, general support alignment procedures	4-10*d*	4-11
Test equipment chart, troubleshooting	2-3*e*	2-3
Test equipment required, troubleshooting	2-3	2-3
Test facilities required, depot overhaul standards	6-3	6-1
Test jacks, AC battery charger	7-6*f*	7-3
Test setup, troubleshooting	2-5	2-5
Tests on Radio Set AN/TRC-77(*), depot overhaul standards	6-5	6-2
Transistor controlled overload circuit, ac battery charger	7-6*b*	7-1
Transmitter:		
Frequency stability test, general support	5-7	5-11
Keyer waveform test, general support	5-6	5-9
Power output test, general support	5-5	5-7
Sidetone oscillator test, general suppport	5-8	5-13
Troubleshooting:		
AC battery charger	7-7	7-3
Chart	2-6*d*	2-5
General instructions	2-1	2-1
Power supply	2-6*d*(3)	2-9
Receiver	2-6*d*(2)	2-8
Transmitter	2-6*d*(1)	2-5
Use of chart, troubleshooting	2-6*b*	2-5
Voltage charts, general support troubleshooting	4-5*c*	4-4
Voltage measurements, troubleshooting	2-2*d*(1)	2-2



NOTES: 1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UHF
2. ▭ INDICATES EQUIPMENT MARKING.
3. ALL WAFERS OF SWITCH S201 ARE SHOWN IN CHANNEL 1 POSITION.
4. SWITCH 202 IS SHOWN IN POSITION 1.
5. SWITCH S301 AND SWITCH S203 ARE SHOWN IN THE OFF POSITION.
6. SWITCH S204 IS SHOWN IN OPERATE POSITION.
7. SWITCH S302 IS SHOWN DEACTIVATED; ACTIVATED ONLY WHEN SWITCH S301 IS IN XMIT POSITION.
8. IN THE AN/TRC-77, USE B WIRING AND COMPONENTS. IN THE AN/TRC-77A, USE A WIRING AND COMPONENTS.
9. DIFFERENCES OF COMPONENT TYPES BETWEEN THE TWO MODELS ARE SHOWN IN THE FOLLOWING TABLE:

COMPONENT	RADIO SET AN/TRC-77	RADIO SET AN/TRC-77A
CR302 THROUGH CR321	TYPE IN647	JAN IN647
CR322	TYPE IN658	USA IN658
CR323	TYPE IN457	TYPE IN1614
J301, J302	7-PIN	2 PIN
P301, P302	CONNECTOR	CONNECTOR
Q201, Q202	TYPE 2N1655	USA 2N1234
Q301	TYPE 2N1039	USN 2N1039
Q302	TYPE 2N1544	USA 2N297A

COMPONENT	RADIO SET AN/TRC-77	RADIO SET AN/TRC-77A
Q303, Q304	TYPE 2N174	JAN 2N174
V201	TYPE 3B4A	USA 3B4WA
V202	TYPE 2E24	JAN 2E24
CR202	TYPE IN459	JAN IN459
CR203	TYPE IN748A	USN IN748A
CR204	TYPE IN30158	USA IN3015B
CR205	TYPE 4E20	TYPE IN3489
CR301	TYPE 1.5MI3.5	USN IN30238

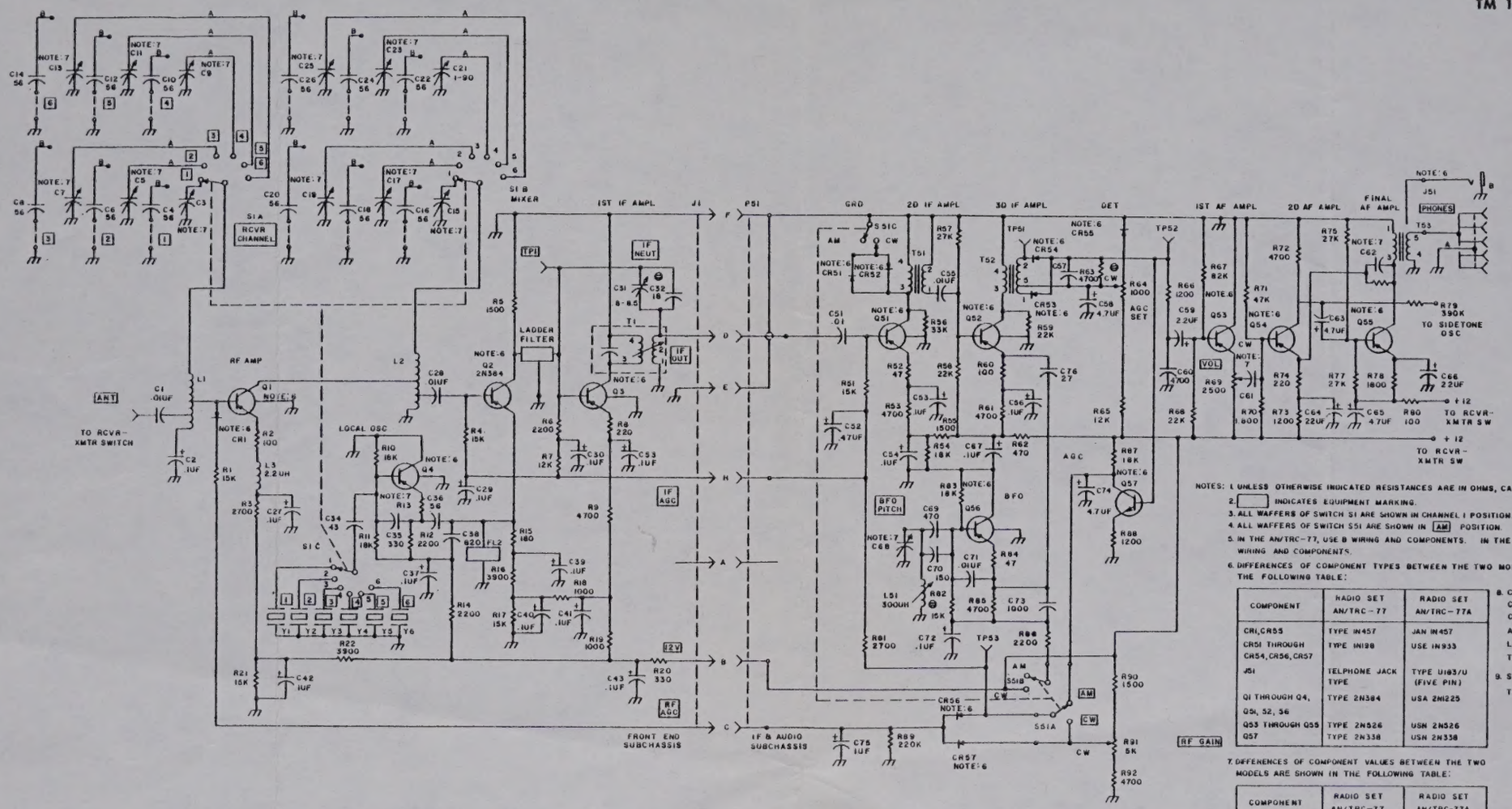
10. DIFFERENCES OF COMPONENT VALUES BETWEEN THE TWO MODELS ARE SHOWN IN THE FOLLOWING TABLE:

COMPONENT	RADIO SET AN/TRC-77	RADIO SET AN/TRC-77A
C206 THROUGH C211, 217, 218, 220, 221, 223, THROUGH 226, 228, 229, 231, 232	1-900UUF	1-180UUF
C214	3300 UUF	0.1 UF
C215	3300 UUF	0.047 UF
L211	220 YH	NOT USED

11. CAPACITORS C216, C219, C222, C227, C230, C233 AND ASSOCIATED TUNING LINKS ARE NOT PART OF THE AN/TRC-77A.
12. SYMBOL: ⌇ INDICATES TUNING LINK.

TM5820-473-35-59

Figure 7-7. Radio Set AN/TRC-77(*) transmitter schematic diagram.



NOTES: 1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF.
2. [ ] INDICATES EQUIPMENT MARKING.
3. ALL WAFFERS OF SWITCH S1 ARE SHOWN IN CHANNEL 1 POSITION.
4. ALL WAFFERS OF SWITCH S51 ARE SHOWN IN [AM] POSITION.
5. IN THE AN/TRC-77, USE B WIRING AND COMPONENTS. IN THE AN/TRC-77A, USE A WIRING AND COMPONENTS.
6. DIFFERENCES OF COMPONENT TYPES BETWEEN THE TWO MODELS ARE SHOWN IN THE FOLLOWING TABLE:

COMPONENT	RADIO SET AN/TRC-77	RADIO SET AN/TRC-77A
CR1, CR55	TYPE 1N457	JAN 1N457
CR51 THROUGH CR54, CR56, CR57	TYPE 1N198	USE 1N933
J51	TELPHONE JACK TYPE	TYPE U183/U (FIVE PIN)
Q1 THROUGH Q4, Q54, 52, 56	TYPE 2N384	USA 2N1225
Q53 THROUGH Q55	TYPE 2N526	USN 2N526
Q57	TYPE 2N338	USN 2N338

8. CAPACITORS C4, C6, C8, C10, C12, C14, C16, C18, C20, C22, C24, C26, AND ASSOCIATED TUNING LINKS ARE NOT PART OF THE AN/TRC-77A.
9. SYMBOL: ⊖ INDICATES TUNING LINK.

7. DIFFERENCES OF COMPONENT VALUES BETWEEN THE TWO MODELS ARE SHOWN IN THE FOLLOWING TABLE:

COMPONENT	RADIO SET AN/TRC-77	RADIO SET AN/TRC-77A
C3, 5, 7, 9, 11, 13, 15, 17, 19, 23, 25.	1-90 UUF	1-180 UUF
C61	5UF, 25V	.15 UF, 150V
C62	1000 UUF	150 UUF
C68	3-20 UUF	2.8-16 UUF
R13	27 OHMS (SERIAL NUMBERS UNDER 60-100 OHMS) (SERIAL NUMBERS 60 AND OVER-27 OHMS)	27 OHMS

TM5820-473-35-60

Figure 7-6. Radio Set AN/TRC-77(*) receiver schematic diagram.